United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Iowa Agriculture and
Home Economics
Experiment Station;
Cooperative Extension
Service, Iowa State
University; and Division of
Soil Conservation, Iowa
Department of
Agriculture and Land
Stewardship

Soil Survey of Cherokee County, Iowa

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How To Use This Soil Survey

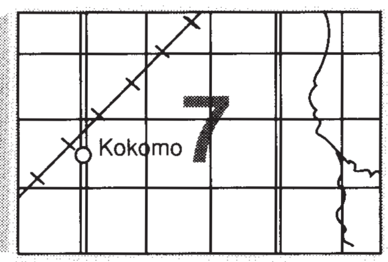
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

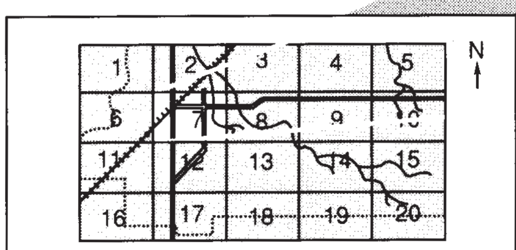
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



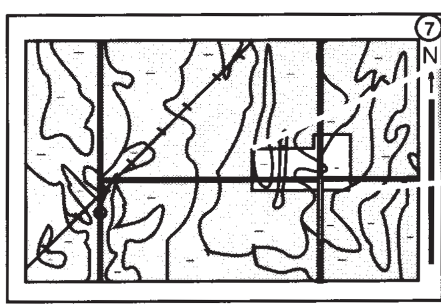
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

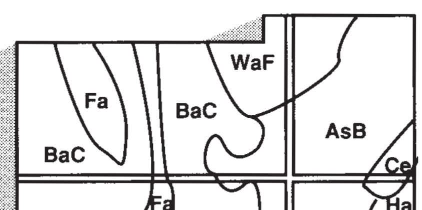


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1986. Soil names and descriptions were approved in 1987. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1987. This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship. It is part of the technical assistance furnished to the Cherokee County Soil Conservation District. Funds appropriated by Cherokee County were used to defray part of the cost of the survey.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of Storden soils on side slopes in the uplands. Terril and Coland soils are in the narrow drainageways below the Storden soils.

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Issued July 1989

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Summary of Tables

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Preface

This soil survey contains information that can be used in land-planning programs in Cherokee County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Cherokee County, Iowa

By Dale Ceolla, Soil Conservation Service

Fieldwork by Dale Ceolla, Mike Hosbein, and David Reeves, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship

CHEROKEE COUNTY is in the northwestern part of Iowa (fig. 1). It has a total area of 366,720 acres, or 573 square miles. It is about 57 miles northeast of Sioux City. Cherokee, the county seat, has a population of 6,996.

Most of the acreage is farmland. Most cropland is used for corn and soybeans. Hogs and feeder cattle for market are the principal livestock.

This survey updates the soil survey of Cherokee County published in 1924 *(7)*. It provides additional information and larger maps that show the soils in greater detail.

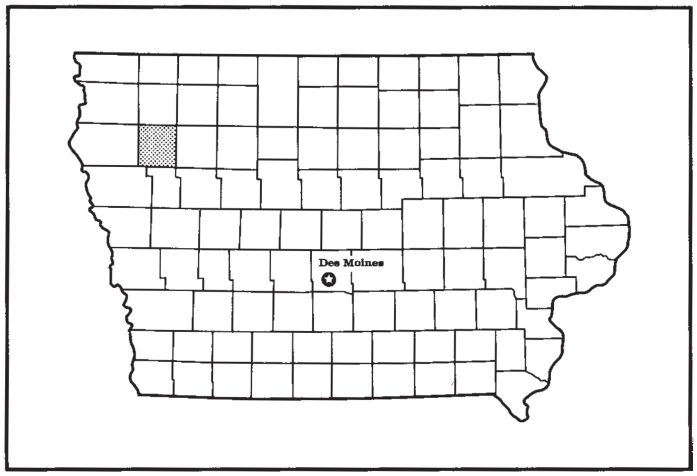

Figure 1.—Location of Cherokee County in Iowa.

General Nature of the County

The history and development, climate, relief and drainage, farming, transportation facilities, and natural resources of Cherokee County are described in this section.

History and Development

The area that is now Cherokee County was acquired from France as part of the Louisiana Purchase in 1803. The Mill Creek Indians moved into the area about 900 A.D. *(3, 12)*. They remained there until about 1600. The Plains Indians used this area as a hunting ground from about 1600 until the period 1856-72, when they were displaced by settlers.

Cherokee County was one of the 49 counties in the state divided from Indian Treaty lands by the Third Iowa General Assembly in 1851. The names for the counties chosen by the lawmakers hadn't any connection to the area or its history. Pioneers made their homes in the

fertile wooded valleys before venturing to develop the open plains. The first of these to arrive in the county was Robert Perry in 1856. Later that year he persuaded scouts of the (Milford) Massachusetts Emigration Company to settle in the Little Sioux River Valley on a tract at the present-day northeast city limits of Cherokee.

The railroad was completed east-west in 1870. A depot was built and prompted the platting of the town of New Cherokee. In 1888 the railroad was built north and south from Cherokee (the "New" was deleted). Larrabee was established as a station, Quimby was platted, and Washta was moved across the river to be on the railroad. Settlers arrived from states east of the Mississippi River as well as from Germany, Sweden, and Scotland. In 1869 the population of Cherokee County was 454.

Climate

Prepared by the National Climatic Data Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Cherokee in the period 1951 to 1984. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 19 degrees F, and the average daily minimum temperature is 9 degrees. The lowest temperature on record, which occurred at Cherokee on January 20, 1970, is -35 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Cherokee on July 8, 1980, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 28.37 inches. Of this, about 21 inches, or 75 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 6.25 inches at Cherokee on June 7, 1953. Thunderstorms occur on about 44 days each year.

The average seasonal snowfall is about 32 inches. The greatest snow depth at any one time during the period of record was 27 inches. On the average, 8 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in spring.

Relief and Drainage

Cherokee County is drained mainly by the Little Sioux River, Maple River, Mill Creek, and West Fork Little Sioux River. A small area of about six sections in the northwest part of the county drains to the Floyd River. The Little Sioux River, the principal stream in the county, flows from the northeast to the southwest. It is 150 to 180 feet lower than surrounding uplands. The river is about 1,197 feet above sea level where it enters the county in the northeast corner and 1,115 feet above sea level where it leaves the county in the south. Its valley has distinct alluvial terraces underlain with sand and gravel; the adjacent hills are gently rolling to very steep, and have numerous small streams. The valley upstream from Cherokee is narrow.

The source of the Maple River is just east of Cherokee County. The river drains most of three townships on the east side of the county. It leaves the county near the southeast corner. The river valley is flat, and has distinct alluvial terraces.

Mill Creek is a major tributary of the Little Sioux River where they join just north of Cherokee. Its valley is deep like that of the Little Sioux Valley. The meanders on Mill Creek are long and sweeping, and especially so on the downstream part of the creek. The West Fork of the Little Sioux River has its source in Marcus Township. It drains most of two townships on the west side of the county. The West Fork Little Sioux River and Maple River flow south and southwest of Cherokee County and enter the Missouri River Valley, where they become tributaries of the Little Sioux River, which is a tributary of the Missouri River.

Slopes generally are 9 percent or less in the southwestern quadrant of the county and mostly 5 percent or less in the rest of the county. However, along the Little Sioux River and Mill Creek and their tributaries, slopes range to as much as 45 percent or more. Elevations range from about 1,521 feet above

sea level at the county line east of Larrabee to about 1,115 feet where the Little Sioux River leaves the county.

Farming

The first settlers in Cherokee County, mainly farmers, found a native vegetation that consisted of primarily tall prairie grasses and trees along the Little Sioux River and Mill Creek. Their problems were those of plowing up the dense sod, fencing the land, and marketing crops.

The legislation establishing soil conservation districts stirred the interest of many landowners in Cherokee County. They recognized the problems of water erosion and soil blowing. The Cherokee Soil and Water Conservation District was organized on April 18, 1944.

In 1985, about 285,500 acres was cropland. The 1,170 farms in the county averaged about 300 acres in size. Although in recent years the number of farms in the county generally has decreased, the size of individual farms generally has increased. Many farms are cash grain, but some crops harvested are fed to livestock on the farms where the crops are grown.

Transportation Facilities

Cherokee County is crisscrossed by hard-surfaced roads and highways. Access to market roads is available in all areas. U.S. Highway 59, running north and south, and Iowa Highway 3, running east and west, intersect at Cherokee. Iowa Highway 7 begins in the eastern part of the county and goes east, Iowa Highway 31 begins in the southern part of the county and goes southwest, and Iowa Highway 143 begins in the western part of the county and goes north. A railway company and a bus line provide service to the county. Cherokee has a municipal airport.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for cultivated crops and for grass grazed by livestock. Other natural resources are gravel, sand, wood, and the scenery.

The most extensive source of sand and gravel is the alluvial terraces adjacent to the Little Sioux River, Mill Creek, and the Maple River. The sand and gravel is used for road surfacing and as concrete aggregate. The native timber adjacent to the Little Sioux River is a noncommercial source for wood products. The rolling hills of fields and farmlands make beautiful scenes of agriculture. The steep hills and the Little Sioux River Valley have natural beauty and provide abundant areas for outdoor recreation.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, soil reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists

assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Marcus-Primghar-Galva Association

Nearly level and gently sloping, poorly drained, somewhat poorly drained, and well drained, silty soils formed in loess; on uplands

This association consists of soils on broad flats and drainageways in the uplands. It is on the most stable upland position in the county, the divide between two major watersheds. In the association, the drainageways are poorly defined, and in places the depressions are ponded. Slopes range from 0 to 5 percent.

This association makes up about 4 percent of the county. It is about 36 percent Marcus soils, 31 percent Primghar soils, 27 percent Galva soils, and 6 percent soils of minor extent (fig. 2).

Marcus soils are poorly drained and on broad flats and concave drainageways in the uplands. Primghar soils are somewhat poorly drained and on linear to very slightly convex broad divides, concave side slopes, and drainageways in the uplands. Galva soils are well drained and on broad flats, slightly convex ridgetops, and side slopes in the uplands.

Typically, the surface layer of Marcus soils is black, friable silty clay loam about 10 inches thick. The subsurface layer is black, friable silty clay loam about 9 inches thick. The lower part is mottled. The subsoil is olive gray, mottled, friable silty clay loam about 27 inches thick. The substratum to a depth of about 60 inches is olive gray and light olive gray, mottled, calcareous silt loam.

Typically, the surface layer of Primghar soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 32 inches thick. The upper part is dark grayish brown, mottled silty clay loam; and the lower part is grayish brown, mottled silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and strong brown, calcareous silt loam.

Typically, the surface layer of Galva soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 28 inches thick. The upper and middle parts are brown silty clay loam; and the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

The minor soils in this association are Afton and Colo soils. The poorly drained Afton soils have a thick, dark colored surface soil and are on the lower parts of upland drainageways. The poorly drained Colo soils have a thick, dark colored surface soil. They are on small stream bottom land and the lower parts of upland drainageways.

This association is used mainly for cultivated crops, but some small areas are used for pasture. If properly managed, the major soils are well suited to intensive row cropping. In uncultivated areas the soils are mostly wet. The main management concerns are improving

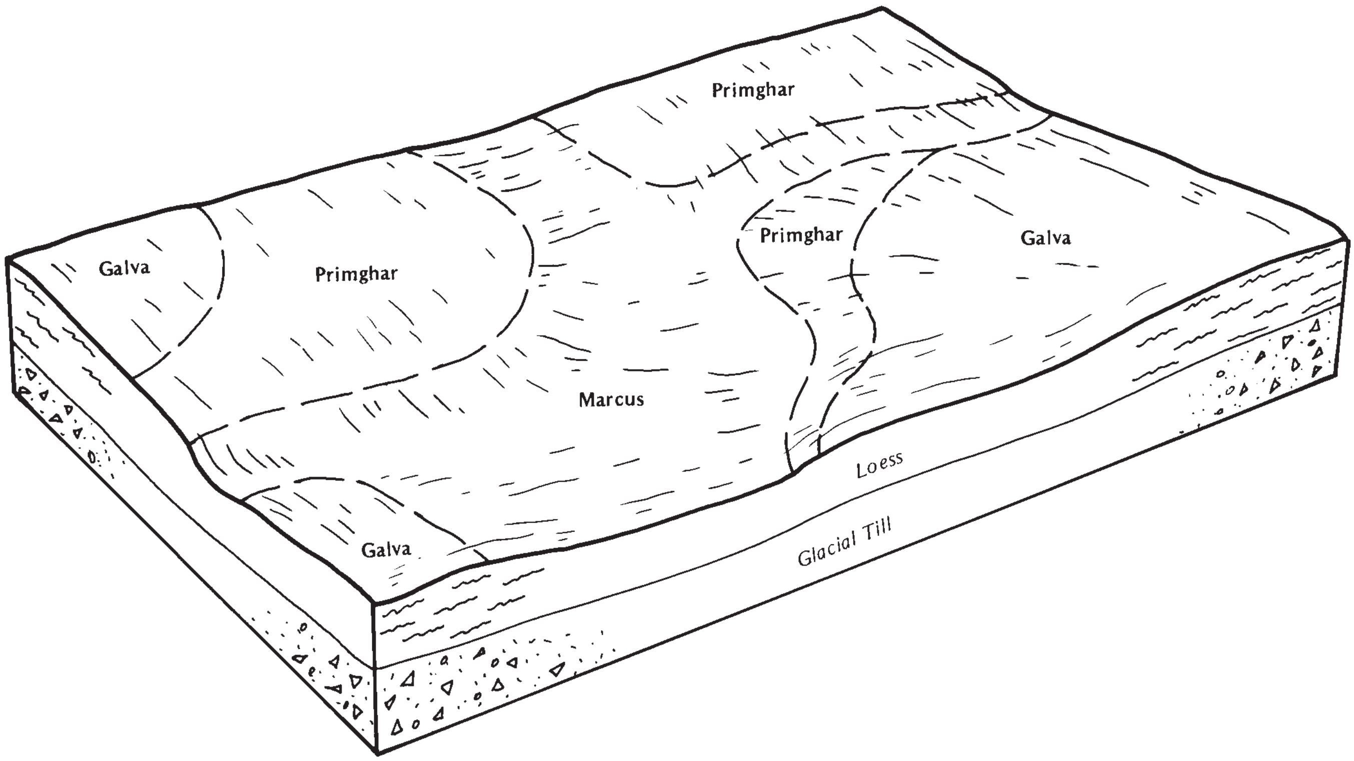

Figure 2.—Typical pattern of soils and parent material in the Marcus-Primghar-Galva association.

drainage, controlling erosion, and maintaining or improving tilth and fertility.

2. Galva-Primghar Association

Nearly level and gently sloping, well drained and somewhat poorly drained, silty soils formed in loess; on uplands

This association consists of soils on convex ridgetops, side slopes, and drainageways in the uplands. It is moderately dissected by drainageways and small streams. Slopes range from 0 to 5 percent.

This association makes up about 31 percent of the county. It is about 64 percent Galva soils, 15 percent Primghar soils, and 21 percent soils of minor extent (fig. 3).

Galva soils are well drained and on broad flats, convex ridges, and side slopes in the uplands. Primghar soils are somewhat poorly drained and on linear to slightly convex ridges, concave side slopes, and drainageways in the uplands.

Typically, the surface layer of Galva soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 28 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

Typically, the surface layer of Primghar soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 32 inches thick. The upper part is dark grayish brown, mottled silty clay loam; the lower part is grayish brown, mottled silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and strong brown, calcareous silt loam.

The minor soils in this association are Afton, Colo, Marcus, and Sac soils. The poorly drained Afton and Colo soils have a thick, dark colored surface soil and are on the lower parts of upland drainageways. The poorly drained Marcus soils are on concave drainageways in the uplands. The well drained Sac soils have loam or clay loam glacial till at depths of 24 to 40

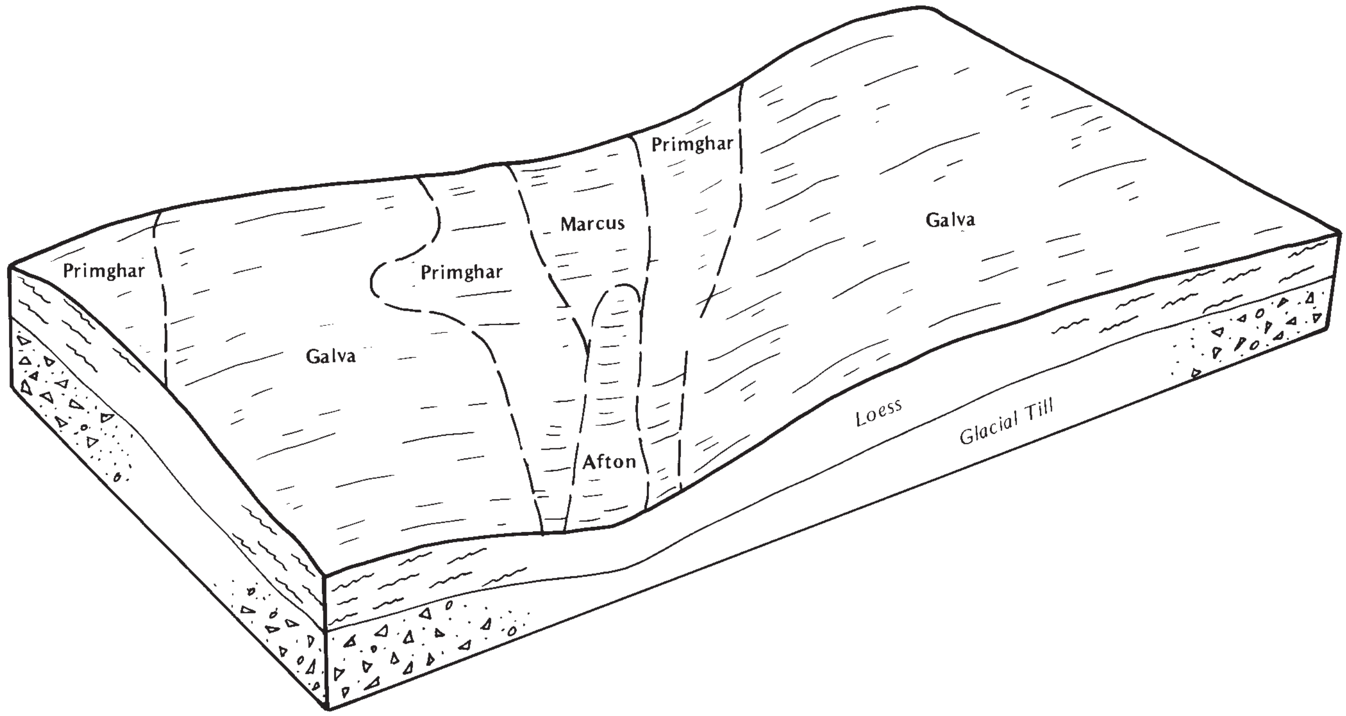

Figure 3.—Typical pattern of soils and parent material in the Galva-Primghar association.

inches and are on convex ridges and side slopes in the uplands.

This association is used mainly for cultivated crops, but some small areas are used for pasture. If properly managed, the major soils are well suited to intensive row cropping. The main management concerns are controlling erosion, improving drainage, and maintaining or improving tilth and fertility.

3. Omadi-Colo-Allendorf Association

Nearly level and gently sloping, moderately well drained, poorly drained, and well drained, silty soils formed in alluvium and loess; on bottom land and stream terraces

This association consists of soils in the valley of the Little Sioux River. Slopes range from 0 to 5 percent.

This association makes up about 6 percent of the county. It is about 21 percent Omadi soils, 20 percent Colo soils, 20 percent Allendorf and similar soils, and 39 percent soils of minor extent.

Omadi soils are moderately well drained and are on bottom land. Colo soils are poorly drained and are on bottom land. Allendorf soils are well drained and are on stream terraces.

Typically, the surface layer of Omadi soils is very dark gray, friable, calcareous silty clay loam about 14 inches thick. The next layer is very dark gray, friable, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is multicolored, stratified, calcareous silt loam and silty clay loam.

Typically, the surface layer of Colo soils is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 31 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 7 inches thick. The substratum to a depth of about 60 inches is dark gray, friable silt loam.

Typically, the surface layer of Allendorf soils is very dark gray, friable silty clay loam about 9 inches thick. The subsurface layer is dark brown, friable silty clay loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown and yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous gravelly loamy sand.

The minor soils in this association are Coland soils, Fluvaquents, and Kennebec, Spillville, and Turlin soils. The poorly drained Coland soils are clay loam and are on bottom land. The poorly drained Fluvaquents have variable textures and are on old meandering stream channels, low natural levees, sloughs, and oxbows on bottom land. The moderately well drained Kennebec soils have a thick, dark colored surface soil and are on low stream terraces. The moderately well drained Spillville soils are loam and are on alluvial fans, foot slopes, and bottom land. Turlin soils have a calcareous subsoil and substratum and are on stream terraces and alluvial fans.

This association is used mainly for cultivated crops. If properly managed, the major soils are well suited to intensive row cropping. The wetter soils and old stream channel areas are used mainly for pasture or for timber and pasture. These areas are subject to frequent flooding for long periods and consequently prohibit access to soil areas that are commonly cropped. Several major sand and gravel pits are located in this association. The principal management concerns are improving drainage, controlling flooding, controlling erosion, and maintaining or improving tilth and fertility.

4. Colo-Galva Association

Nearly level to moderately sloping, poorly drained and well drained, silty soils formed in alluvium and loess; on bottom land and stream terraces

This association consists of soils on bottom land and loess-covered stream terraces. Slopes range from 0 to 9 percent.

This association makes up about 9 percent of the county. It is about 42 percent Colo soils, 27 percent Galva soils, and 31 percent soils of minor extent.

Colo soils are poorly drained and on bottom land. Galva soils are well drained and on loess-covered stream terraces.

Typically, the surface layer of Colo soils is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 31 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 7 inches thick. The substratum to a depth of about 60 inches is dark gray, friable silt loam.

Typically, the surface layer of Galva soils is black, friable silty clay loam about 10 inches thick. The subsurface layer is black and dark brown, friable silty clay loam about 13 inches thick. The subsoil is brown and yellowish brown, friable silty clay loam about 50 inches thick. The substratum to a depth of about 114 inches is brown silt loam. Stratified sand and gravel are below a depth of about 114 inches.

The minor soils in this association are Coland, Hawick, Spillco, and Spillville soils. The poorly drained Coland soils have more sand in the solum and are on bottom land. The excessively drained Hawick soils have coarser textures throughout and are on side slopes on stream terraces. The moderately well drained Spillco and Spillville soils have more sand in the surface soil, and are on bottom land and low stream terraces.

This association is used mainly for cultivated crops. If properly managed, the major soils are well suited to intensive row cropping. In uncultivated areas, the soils are mostly wet. The main management concerns are improving drainage, controlling erosion, and maintaining or improving tilth and fertility.

5. Sac-Galva-Primghar Association

Gently sloping and moderately sloping, well drained and somewhat poorly drained, silty soils formed in loess or in loess and the underlying glacial till; on uplands

This association consists of soils on convex ridgetops, convex side slopes, and drainageways in uplands. Slopes range from 1 to 9 percent.

This association makes up about 5 percent of the county. It is about 38 percent Sac soils, 32 percent Galva soils, 16 percent Primghar soils, and 14 percent soils of minor extent (fig. 4).

Sac and Galva soils are gently sloping and moderately sloping, well drained, and on convex ridgetops and side slopes in the uplands. Primghar soils are gently sloping, somewhat poorly drained, and on concave side slopes and drainageways in the uplands.

Typically, the surface layer of Sac soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 10 inches thick. The subsoil is friable and about 21 inches thick. The upper part is brown and dark yellowish brown silty clay loam; the next part is dark yellowish brown silty clay loam; the lower part is dark yellowish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

Typically, the surface layer of Galva soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 28 inches thick. The upper and middle parts are brown silty clay loam; the lower

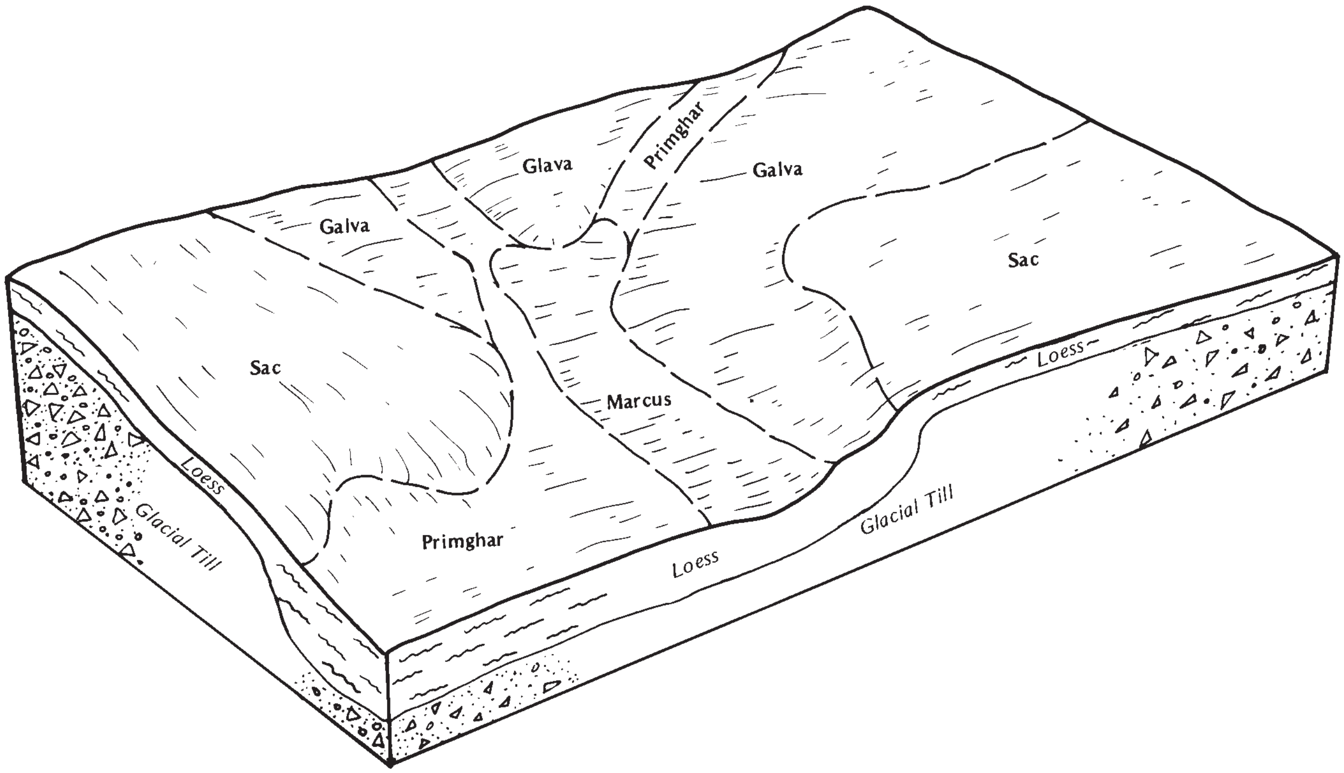

Figure 4.—Typical pattern of soils and parent material in the Sac-Galva-Primghar association.

part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

Typically, the surface layer of Primghar soils is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 32 inches thick. The upper part is dark grayish brown, mottled silty clay loam; the lower part is grayish brown, mottled silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and strong brown silt loam.

The minor soils in this association are Afton, Everly, and Marcus soils. The poorly drained Afton soils have a thick, dark colored surface soil and are on the lower parts of upland drainageways. The well drained Everly soils have coarse fragments above a depth of 40 inches and are on convex ridgetops and side slopes in the uplands. The poorly drained Marcus soils are in drainageways in the uplands.

This association is used mainly for cultivated crops, but some small areas are used as pasture. If properly managed, the major soils are well suited to intensive row cropping. In uncultivated areas the soils are mostly wet. The main management concerns are controlling erosion, improving drainage, and maintaining or improving tilth and fertility.

6. Steinauer-Storden Association

Strongly sloping to very steep, well drained, loamy soils formed in glacial till; on uplands

This association consists of soils on side slopes in uplands. Slopes range from 9 to 50 percent.

This association makes up about 9 percent of the county. It is about 38 percent Steinauer soils, 23 percent Storden soils, and 39 percent soils of minor extent.

Steinauer soils are well drained, formed in clay loam glacial till, and are on side slopes in the uplands. Storden soils are well drained, formed in loam glacial till, and are on side slopes in the uplands.

Typically, the surface layer of Steinauer soils is very dark gray, friable, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, firm, calcareous clay loam about 6 inches thick. The

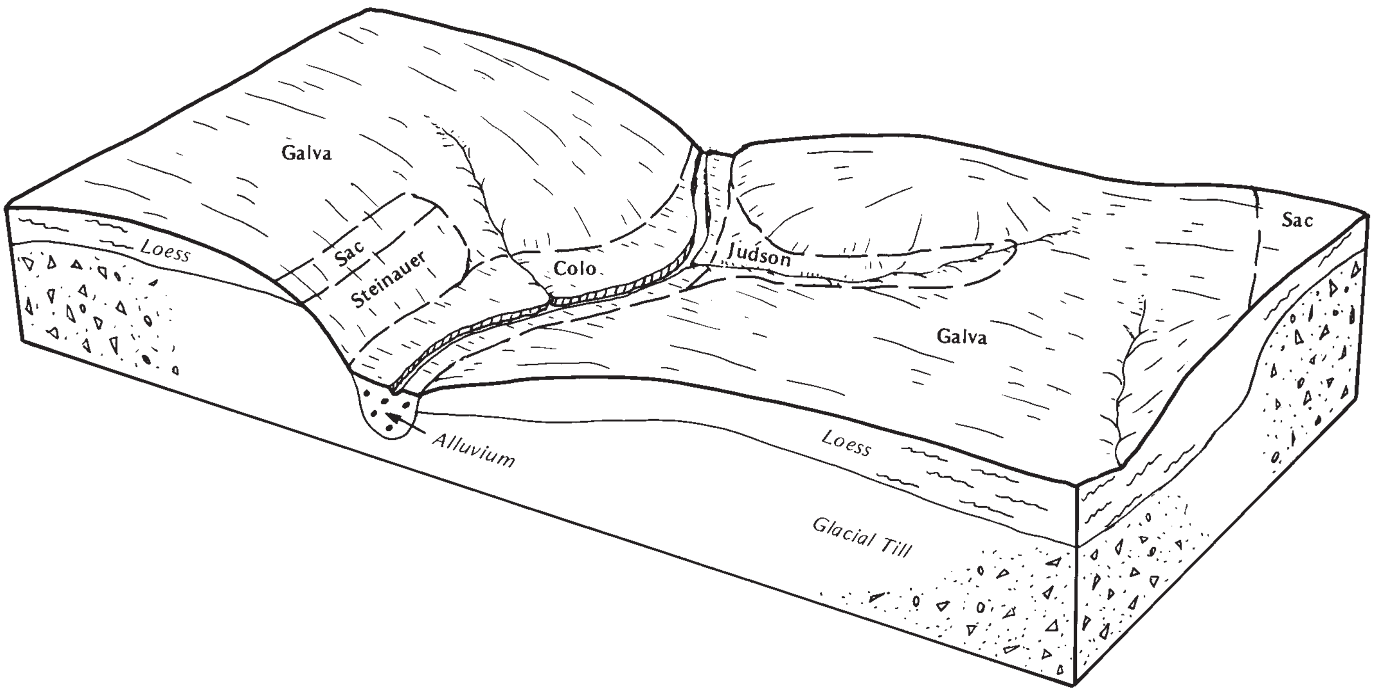

Figure 5.—Typical pattern of soils and parent material in the Galva association.

substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam.

Typically, the surface layer of Storden soils is very dark grayish brown, friable, calcareous loam about 4 inches thick. The subsurface layer is dark grayish brown, friable, calcareous loam about 5 inches thick. The next layer is brown and yellowish brown, friable, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam.

The minor soils in this association are Everly, Galva, Hawick, Sac, and Terril soils. Everly soils formed in loamy surficial sediments and the underlying glacial till and are on convex ridges and side slopes in the uplands. Galva soils formed in loess and are on ridges and side slopes in the uplands and on stream terraces. Hawick soils formed in loamy, sandy, and gravelly glacial deposits and are on side slopes of stream terraces and on upland knobs. Sac soils formed in loess and the underlying loam or clay loam glacial till and are on convex ridgetops and side slopes in the uplands. Terril soils have a thick, dark colored surface soil and are on foot slopes and stream terraces.

The gently sloping to strongly sloping areas of this association generally are used for row crops, and are well suited or suited to corn and soybeans. Generally, the moderately steep to very steep areas are used for pasture and are unsuited to row crops. They are better suited to grasses for pasture. Improved pasture management programs are needed to increase yields. The main management concerns are controlling erosion, grazing management, controlling undesirable plant species, and preventing the formation of gullies. This association has some of the most scenic areas of the county.

7. Galva Association

Gently sloping to strongly sloping, well drained, silty soils formed in loess; on uplands

This association consists of soils on convex ridgetops and side slopes in uplands. Slopes range from 2 to 14 percent.

This association makes up about 36 percent of the county. It is about 74 percent Galva soils and 26 percent soils of minor extent (fig. 5).

Galva soils are on convex ridgetops and side slopes in the uplands and are well drained.

Typically, the surface layer of Galva soils is black, friable silty clay loam about 8 inches thick. The

subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 7 inches thick. The subsoil is friable and about 27 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam.

The minor soils in this association are Colo, Judson, Sac, and Steinauer soils. The poorly drained Colo soils have a thick, dark colored surface soil and are on small stream bottom land and the lower parts of upland drainageways. The moderately well drained Judson soils have a thick, dark colored surface soil and are on concave foot slopes and convex alluvial fans. The well drained Sac soils have clay loam glacial till at depths of 24 to 40 inches and are on convex ridgetops and side slopes. The well drained Steinauer soils formed in clay loam glacial till and are on convex side slopes in the uplands.

This association is used mainly for cultivated crops. Some of the steeper, more eroded areas are used for hay and pasture. These soils are well suited or suited to intensive row cropping. The main management concerns are controlling erosion, preventing the formation of gullies, and maintaining or improving tilth and fertility.

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Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Galva silty clay loam, 2 to 5 percent slopes, is a phase of the Galva series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Steinauer-Hawick complex, 25 to 40 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, sand and gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

1C3—Ida silt loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, well drained soil is on narrow, rounded ridgetops and side slopes in the uplands. Areas range from 2 to 10 acres in size and are long and narrow.

Typically, the surface layer is dark brown and brown, friable, calcareous silt loam about 8 inches thick. Plowing has mixed some dark yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous silt loam. In many places accumulations of calcium carbonate are on the surface. In some places the uppermost 24 inches is silty clay loam and noncalcareous.

Permeability in the Ida soil is moderate, and runoff is medium. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Ida soils.

A cover of pasture plants or hay is effective in controlling erosion. Species that grow well in a calcareous soil should be selected for planting. Overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces the forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

1D3—Ida silt loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained soil is on upland ridges and side slopes. Areas range from 5 to 75 acres in size and are irregularly shaped.

Typically, the surface layer is dark brown and brown, friable, calcareous silt loam about 8 inches thick. Plowing has mixed some dark yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous silt loam. In many places accumulations of calcium carbonate are on the surface. In some places the substratum is grayish brown. In a few places the uppermost 24 inches is noncalcareous.

Permeability in the Ida soil is moderate, and runoff is medium. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Ida soils.

A cover of pasture plants or hay is effective in controlling erosion. Species that grow well in a calcareous soil should be selected for planting. Overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

1E3—Ida silt loam, 14 to 20 percent slopes, severely eroded. This moderately steep, well drained soil is on side slopes in the uplands. Areas range from 5 to 75 acres in size and are irregularly shaped.

Typically, the surface layer is dark brown and brown, friable, calcareous silt loam about 7 inches thick. Plowing has mixed some dark yellowish brown substratum material into the surface layer. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, calcareous silt loam. It has mottles in the lower part. In many places accumulations of calcium carbonate are on the surface.

Permeability in the Ida soil is moderate, and runoff is rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Ida soils.

A cover of pasture plants or hay is effective in controlling erosion. Planting species that grow well in calcareous soil provides the highest yields. Overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and

reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IVe.

1G—Ida silt loam, 20 to 40 percent slopes. This steep and very steep, well drained soil is on side slopes in the uplands. Areas range from 5 to 60 acres in size and are irregularly shaped.

Typically, the surface layer is dark brown and brown, friable, calcareous silt loam about 5 inches thick. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown, mottled, calcareous silt loam.

Permeability in the Ida soil is moderate, and runoff is very rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil is unsuited to corn, soybeans, and small grain and to legumes for hay mainly because the slopes are steep and very steep and erosion is a hazard. It is better suited to grasses for pasture.

A cover of pasture plants is effective in controlling erosion. Species that grow well in calcareous soil should be selected for planting. Overgrazing or grazing during wet periods causes surface compaction, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

8B—Judson silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on concave foot slopes and convex alluvial fans. Areas range from 5 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is friable silty clay loam about 17 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is brown, friable silty clay loam about 23 inches thick. The lower part is mottled. The substratum to a depth of about 60 inches is brown, mottled silty clay loam.

Permeability in the Judson soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in sedimentation and gullying. Measures to control the runoff on the soils upslope are needed. If cultivated crops are grown, erosion is a hazard. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Grassed waterways help to remove excess water and prevent gullying. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

11B—Colo-Judson silty clay loams, 0 to 5 percent slopes. These nearly level and gently sloping soils are along narrow upland drainageways and the adjacent foot slopes. The poorly drained Colo soil is near the drainageways and is subject to flooding. The moderately well drained Judson soil is in narrow bands between the Colo soil and the higher lying soils on the adjacent hillsides. Areas range from 5 to 50 acres in size and are long and narrow. They are about 50 percent Colo soil, 35 percent Judson soil, and 15 percent other soils. These soils are so intricately mixed or so narrow that mapping them separately is impractical.

Typically, the surface layer of the Colo soil is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 31 inches thick. The next layer is very dark gray, mottled silty clay loam about 7 inches thick. The substratum to a depth of about 60 inches is dark gray silt loam. In places the substratum is olive gray, mottled, calcareous silt loam within a depth of 20 to 36 inches.

Typically, the surface layer of the Judson soil is black, friable silty clay loam about 8 inches thick. The subsurface layer is friable silty clay loam about 17 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is brown, mottled, friable silty clay loam about 23 inches thick. The lower part is mottled. The substratum to a depth of

about 60 inches is brown, mottled silty clay loam. In places the surface soil is less than 24 inches thick and the subsoil is dark grayish brown, mottled silty clay loam.

Permeability in these Colo and Judson soils is moderate. Runoff is slow on the Colo soil and medium on the Judson soil. The Colo soil has a seasonal high water table. Available water capacity is high in both soils. The subsurface layer of the Colo soil generally has a medium supply of available phosphorus and potassium. The subsoil of the Judson soil generally has a low supply of available phosphorus and potassium.

Most areas are cultivated. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Some areas are subject to flooding of short duration from small streams upslope. A drainage system will reduce the wetness and provide good aeration and a deep root zone for plants. A tile drainage system generally functions well if the tile is properly installed and adequate outlets are available. In some areas runoff from soils upslope results in sedimentation. Measures to control runoff on the soils upslope are needed. Grassed waterways help to remove excess water and prevent gullying. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and crop rotations that include meadow crops help to prevent excessive soil loss. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

26—Kennebec silty clay loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on low stream terraces. It is subject to flooding. Areas range from 5 to 25 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is friable silty clay loam about 34 inches thick. The upper part is black, the next part is very dark gray, and the lower part is very dark grayish brown. Below that, to a depth of about 60 inches or more, the soil is very dark grayish brown and dark brown, mottled, friable silty clay loam. In places the subsoil is brown within a depth of 36 inches.

Permeability in the Kennebec soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is very high. The subsoil generally has a low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is I.

27—Terril loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on plane to slightly concave stream terraces. Areas range from 2 to 20 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 27 inches thick. The upper part is black, the next part is very dark brown, and the lower part is very dark grayish brown. The subsoil is about 22 inches thick. The upper part is dark brown, friable loam; the next part is brown and dark yellowish brown, friable loam; and the lower part is brown and dark yellowish brown, friable clay loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown loam. In a few places the subsoil is dark grayish brown and calcareous as shallow as a depth of 25 inches. In some places the soil is silty clay loam throughout.

Permeability in the Terril soil is moderate, and runoff is slow. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in sedimentation and gullying. In some areas measures to control runoff on the soils upslope are needed. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to

prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

27B—Terril loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on plane to slightly concave foot slopes and on convex alluvial fans. Areas ranges from 2 to 15 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 25 inches thick. The upper part is black, the next part is very dark brown, and the lower part is very dark grayish brown. The subsoil is about 21 inches thick. The upper part is dark brown, friable loam; the next part is brown and dark yellowish brown, friable loam; and the lower part is brown and dark yellowish brown, friable clay loam. The substratum to a depth of about 60 inches is brown and dark yellowish brown loam. In a few places the subsoil is dark grayish brown and is calcareous as shallow as a depth of 25 inches. In some places this soil has a texture of silty clay loam throughout.

Permeability in the Terril soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in sedimentation and gullying. Measures to control the runoff on the soils upslope are needed. If cultivated crops are grown, erosion is a hazard. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Grassed waterways help to remove excess water and prevent gullying. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

27C—Terril loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on plane to slightly concave foot slopes and convex alluvial fans. Areas range from 2 to 12 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 24 inches thick. The upper part is black, the next part is very dark brown, and the lower part is very dark grayish brown. The subsoil is about 21 inches thick. The upper part is dark brown, friable loam; the next part is brown and dark yellowish brown, friable loam; and the lower part is brown and dark yellowish brown, friable clay loam. The substratum to a depth of about 60 inches is dark yellowish brown loam. In a few places the subsoil is calcareous and is as shallow as 24 inches. In some places the soil has a texture of silty clay loam throughout.

Permeability in the Terril soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in sedimentation and gullying. Measures to control runoff on the soils upslope are needed. If cultivated crops are grown, erosion is a hazard. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Grassed waterways help to remove excess water and prevent gullying. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

28B—Dickman sandy loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on uplands and

stream terraces. Areas range from 2 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable sandy loam about 8 inches thick. The subsurface layer is black, friable sandy loam about 8 inches thick. The subsoil is very friable loamy sand about 18 inches thick. The upper part is brown and dark brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous sand. In some swales loamy sand or sand is at a depth of as much as 25 inches.

Permeability in the Dickman soil is moderately rapid, and runoff is medium. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil is suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. This soil is droughty because of the sandy subsoil and substratum. Blowing soil can damage seedlings on this soil and on the adjacent soils. If cultivated crops are grown, practices are needed to control erosion and conserve moisture. These practices include a system of conservation tillage that leaves crop residue on the surface, contour farming, and crop rotations that include meadow crops. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility and help to conserve moisture.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet or too dry, however, causes poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IIIe.

28D—Dickman sandy loam, 5 to 12 percent slopes. This moderately sloping to strongly sloping, well drained soil is on uplands and stream terraces. Areas range from 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable sandy loam about 8 inches thick. The subsurface layer also is black, friable sandy loam about 8 inches thick. The subsoil is very friable loamy sand about 16 inches thick. The upper part is brown and dark brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is yellowish brown, calcareous sand. In some swales the depth to loamy sand or sand is as much as 25 inches.

Permeability in the Dickman soil is moderately rapid, and runoff is medium. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil is poorly suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. This soil is droughty because of the sandy subsoil and substratum. Blowing soil can damage seedlings on this soil and on the adjacent soils. If cultivated crops are grown, practices are needed to control erosion and conserve moisture. These practices include a system of conservation tillage that leaves crop residue on the surface, contour farming, and crop rotations that include meadow crops. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility and help to conserve moisture.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet or too dry, however, causes poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IVe.

31—Afton silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is in concave drainageways on uplands. It is subject to flooding. Areas range from 3 to 40 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 23 inches thick. The lower part is mottled. The subsoil is mottled, friable silty clay loam about 16 inches thick. The upper part is dark grayish brown, the next part is gray and olive gray, and the lower part is olive gray. The substratum to a depth of about 60 inches is mottled olive gray and yellowish brown, calcareous silt loam. In some places the surface layer is less than 24 inches thick.

Permeability in the Afton soil is moderately slow, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The main management concern is wetness caused by the seasonal high water

table and flooding. A drainage system will reduce wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed and if an adequate outlet is available. Most of the flooding is very brief and occurs before row crops are planted. Timely field operations are important in maintaining good tilth. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

33D—Steinauer clay loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The next layer is yellowish brown, firm, calcareous clay loam about 4 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. The soil contains pebbles throughout. In some places the surface layer is only 3 inches thick because of erosion.

Included with this soil in mapping are some small areas of Everly soils. These soils are not calcareous throughout and are in landscape positions similar to those of Steinauer soils. They make up less than 5 percent of the unit.

Permeability in the Steinauer soil is moderately slow, and runoff is medium. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, as little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Also, returning as much topsoil as possible helps in revegetating the site. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Species that can grow well in a calcareous soil should be selected for planting. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

33F—Steinauer clay loam, 14 to 25 percent slopes. This moderately steep and steep, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 15 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark gray, friable, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, firm, calcareous clay loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. The soil contains pebbles throughout. In a few places in the uppermost 12 to 24 inches the soil is noncalcareous.

Permeability in the Steinauer soil is moderately slow, and runoff is rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil generally is unsuited to corn, soybeans, and small grain because the slope restricts the use of farm machinery and because erosion is a hazard. The soil is better suited to grasses and legumes for hay and pasture.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIe.

33G—Steinauer clay loam, 25 to 40 percent slopes. This very steep, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 15 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark gray, friable, calcareous clay loam about 5 inches thick. The next layer is yellowish brown, firm, calcareous clay loam

about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. The soil contains pebbles throughout. In a few places in the uppermost 12 to 24 inches the soil is noncalcareous.

Included with this soil in mapping are small scattered areas where stones and boulders eroded from the glacial till are on the surface. These areas are on the higher parts of side slopes and make up less than 5 percent of the unit.

Permeability in the Steinauer soil is moderately slow, and runoff is very rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil generally is unsuited to corn, soybeans, and small grain and to legumes for hay because the slope restricts the use of farm machinery and because erosion is a hazard. The soil is better suited to grasses for pasture.

A cover of pasture plants is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil should provide the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. It is subject to flooding. Areas range from 5 to 30 acres in size and are long and narrow.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 25 inches thick. The subsoil to a depth of about 60 inches is very dark gray and dark gray, mottled, firm silty clay loam. In some places the subsoil contains less clay. In some places the soil has a texture of clay loam throughout.

Permeability in the Zook soil is slow, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a medium supply of available phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Crops are subject to damage by wetness, flooding, and sedimentation. A drainage system will reduce the wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed and if an adequate outlet is available. Flood-protection measures are beneficial in most areas. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

72B—Estherville loam, 2 to 5 percent slopes. This gently sloping, somewhat excessively drained soil is on valley drains and stream terraces. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown, friable loam about 9 inches thick. The subsurface layer is very dark grayish brown, friable sandy loam about 4 inches thick. The subsoil is dark yellowish brown, friable sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is dark brown, brown, and yellowish brown, calcareous gravelly loamy sand and gravelly coarse sand. In some places the gravel content is more than 35 percent in the substratum.

Permeability in the Estherville soil is moderately rapid in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn and soybeans. It is better suited to small grain and to grasses and legumes for hay and pasture. The main limitation is the low available water capacity. This soil is droughty because of the sandy and gravelly substratum. It is not suitable for terracing because sand and gravel are too close to the surface. If cultivated crops are grown, erosion is a hazard. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility, help to conserve moisture and prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing when the soil is too wet or too dry causes surface compaction and poor

tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IIIs.

72C—Estherville loam, 5 to 9 percent slopes. This moderately sloping, somewhat excessively drained soil is on valley trains and stream terraces. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown, friable loam about 8 inches thick. The subsurface layer is dark brown, friable sandy loam about 4 inches thick. The subsoil is dark yellowish brown, friable sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is dark brown, brown, and yellowish brown, calcareous gravelly loamy sand and gravelly coarse sand. In some places the gravel content is more than 35 percent in the substratum.

Permeability in the Estherville soil is moderately rapid in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and potassium.

Some areas are cultivated. This soil is poorly suited to corn and soybeans. It is better suited to small grain and to grasses and legumes for hay and pasture. The main limitation is the low available water capacity. The soil is droughty because of the sand and gravel substratum. It is not suitable for terracing because sand and gravel are too close to the surface. If cultivated crops are grown, erosion is a hazard. Contour farming, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility, help to conserve moisture and prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing when the soil is too wet or too dry causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IVs.

77B—Sac silty clay loam, loam substratum, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 25 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 10 inches thick. The subsoil is friable and about 21 inches thick. The upper part is brown and dark yellowish brown silty clay loam; the next part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places yellowish brown, mottled, friable, calcareous loam is below a depth of 40 inches. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Sac soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

77B2—Sac silty clay loam, loam substratum, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 25 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. Plowing has mixed some of the brown subsoil material into the surface

layer. The subsoil is friable and about 32 inches thick. The upper part is brown and dark yellowish brown silty clay loam; the next part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places the surface layer is more than 7 inches thick. In some places this soil has a texture of clay loam throughout.

Permeability in the Sac soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Sac soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

77C—Sac silty clay loam, loam substratum, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 7 inches thick. The subsoil is friable and about 23 inches thick. The upper part is brown silty clay loam; the next part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Sac soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

77C2—Sac silty clay loam, loam substratum, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. Plowing has mixed some of the brown subsoil material into the surface layer. The subsoil is friable and about 30 inches thick. The upper part is brown and dark yellowish brown silty clay loam; the next part is dark yellowish brown silty clay loam; and the lower part is dark yellowish brown, mottled, calcareous loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. In some places the surface layer is more than 7 inches thick. In some places this soil has a texture of clay loam throughout.

Permeability in the Sac soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn,

soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Sac soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

78B—Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 25 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown and brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown, firm, calcareous clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In some places yellowish brown, firm clay loam is below a depth of 40 inches. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Sac soil is moderately slow, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

78B2—Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 25 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is about 27 inches thick. The upper part is brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In some places the surface layer is more than 7 inches thick. In some places this soil has a texture of clay loam throughout.

Permeability in the Sac soil is moderately slow, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly

adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Sac soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

78C—Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown and brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Sac soil is moderately slow, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

78C2—Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 25 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is about 26 inches thick. The upper part is brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. In some places the surface soil is more than 7 inches thick. In some places this soil has a texture of clay loam throughout.

Permeability in the Sac soil is moderately slow, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Sac soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

91—Primghar silty clay loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on linear to slightly convex ridges in the uplands. Areas range from 3 to 250 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 32 inches thick. The upper part is dark grayish brown, mottled, silty clay loam; and the lower part is grayish brown, mottled, calcareous silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and strong brown, calcareous silt loam.

Permeability in the Primghar soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. A drainage system will lower the seasonal high water table and improve the timeliness of field operations. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is I.

91B—Primghar silty clay loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is on concave side slopes and in concave drainageways on uplands. Areas range from 3 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 32 inches thick. The upper part is dark grayish brown, mottled silty clay loam; and the lower part is light olive brown, mottled, calcareous silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and strong brown, calcareous silt loam.

Included with this soil in mapping are some small areas of Marcus soils. These soils are poorly drained and are at lower elevations closer to the waterways. They make up less than 10 percent of the unit.

Permeability in the Primghar soil is moderate, and runoff is medium. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Gullying is a hazard in areas of concentrated runoff. Grassed waterways help to prevent gully erosion. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and crop rotations that include meadow crops help to prevent excessive soil loss. A drainage system will lower the seasonal high water table and improve the timeliness of field operations. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

92—Marcus silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on broad flats and concave drainageways in the uplands. Areas range from 5 to 60 acres in size and are irregularly shaped. A few areas are as large as 400 acres.

Typically, the surface layer is black, friable silty clay loam about 10 inches thick. The subsurface layer is black, friable silty clay loam about 9 inches thick. The lower part is mottled. The subsoil is olive gray, mottled, friable silty clay loam about 27 inches thick. The substratum to a depth of about 60 inches is olive gray and light olive gray, mottled, calcareous silt loam. In some places loam or clay loam glacial till is at a depth of 24 to 40 inches.

Permeability in the Marcus soil is moderately slow, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The main management

concern is wetness caused by the seasonal high water table. A drainage system will reduce wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed and if an adequate outlet is available. Timely field operations are important in maintaining good tilth. Returning crop residue to the surface, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

96—Turlin loam, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on linear to slightly concave foot slopes, low gradient alluvial fans, and low stream terraces. It is subject to flooding. Areas range from 2 to 180 acres in size. The smaller areas are long and irregularly shaped, and the larger areas have a broad, oblong pattern.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is friable loam about 25 inches thick. The upper part is black, and the lower part is very dark gray and very dark grayish brown. The subsoil is dark grayish brown, mottled, friable, calcareous loam to a depth of about 60 inches or more. In places the surface layer and subsoil are silty clay loam.

Permeability in the Turlin soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The main management concern is wetness caused by the seasonal high water table. A drainage system will reduce wetness and improve the timeliness of field operations. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

108—Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes. This nearly level, well drained soil is on stream terraces. Areas range from 10 to 80 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark brown, friable loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable loam about 6 inches thick. The subsoil is friable loam about 15 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown gravelly sand in the upper part, and brown, calcareous gravelly sand in the lower part.

Permeability in the Wadena soil is moderate in the solum and very rapid in the substratum. Runoff is slow. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The low available water capacity is the main limitation. The soil is seasonally droughty because of the sand and gravel substratum. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility, help to conserve moisture and prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing when the soil is too wet or too dry causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IIs.

108B—Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes. This gently sloping, well drained soil is on stream terraces. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark brown, friable loam about 6 inches thick. The subsurface layer is very dark grayish brown, friable loam about 5 inches thick. The subsoil is friable loam about 13 inches thick. The upper part is dark brown, and the lower part is dark yellowish brown. The substratum to a depth of about 60 inches is dark yellowish brown and yellowish brown gravelly sand in the upper part and brown, calcareous gravelly sand in the lower part.

Permeability in the Wadena soil is moderate in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is low. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The low available water capacity is the main limitation. The soil is seasonally droughty because of the sand and gravel substratum. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, the cuts should not expose the sand and gravel substratum because it is low in fertility and difficult to till. Returning as much topsoil as possible helps in revegetating the site. Good tilth generally can be easily maintained. Returning crop residue to the soil and regularly adding other organic material improve tilth and fertility, help to conserve moisture and prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing when the soil is too wet or too dry causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is IIe.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land of large and small streams and on the lower part of upland drainageways. In some places it is on stream terraces and is subject to runoff from adjacent slopes. It is subject to flooding. Most areas range from 10 to 100 acres in size. Areas are irregularly shaped on bottom land of larger streams and are long and narrow along the small streams and upland drainageways.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 32 inches thick. The next layer is very dark gray, mottled, friable silty clay loam about 7 inches thick. The substratum to a depth of about 60 inches is dark gray, friable silt loam. In places 15 to 30 inches of very dark grayish brown silty clay loam and silt loam alluvium overlies a buried soil.

Permeability in the Colo soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsurface layer generally has a medium supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, the main management concerns are wetness caused by the seasonal high water table and by flooding. Most periods of flooding occur before row crops are planted. In some areas flood-protection measures are beneficial. A drainage system will reduce the wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed and if an adequate outlet is available. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

135—Coland clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on bottom land. In some places it is on stream terraces, and is subject to runoff from adjacent slopes. It is subject to flooding. Areas range from 5 to 200 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable clay loam about 8 inches thick. The subsurface layer is black, friable clay loam about 26 inches thick. The next layer is very dark gray, mottled, friable clay loam about 8 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled clay loam.

Included with this soil in mapping are some areas of stratified, recently deposited alluvial sediments that have not been in place long enough for a soil profile to develop. The sediments typically are gravelly sandy loam or sandy loam. These areas are at slightly higher elevations than those of the Coland soil. Also included are some areas of sand and gravel at depths of 24 to 40 inches. They are in similar landscape positions. They make up less than 5 percent of the unit.

Permeability in the Coland soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsurface layer generally has a medium supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and

legumes for hay and pasture. If cultivated crops are grown, the main management concerns are the wetness caused by the seasonal high water table and flooding. Most periods of flooding occur before row crops are planted. In some areas flood-protection measures are beneficial. A drainage system will reduce the wetness and provide good aeration and a deep root zone for plants. Tile drains work well if they are properly installed and if an adequate outlet is available. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

189—Omadi silty clay loam, 0 to 2 percent slopes. This nearly level, moderately well drained, calcareous soil is on bottom land along major streams. It is subject to flooding. Areas range from 3 to 50 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable, calcareous silty clay loam about 14 inches thick. The next layer is very dark gray, friable, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is multicolored, stratified, calcareous silt loam and silty clay loam. In some places after recent flooding, as much as 6 inches of overwash can be deposited.

Permeability in the Omadi soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is very high. The substratum generally has a low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, the main management concerns are flooding and sedimentation (fig. 6). Flood-protection measures are beneficial in some areas but in most areas are impractical. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is I.

309—Allendorf silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on stream terraces. Areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable silty clay loam about 9 inches thick. The subsurface layer is dark brown, friable silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the lower part is dark yellowish brown and yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous gravelly loamy sand. In some places the surface layer and subsoil are loam.

Permeability in the Allendorf soil is moderate in the solum and very rapid in the substratum. Runoff is slow. The available water capacity is moderate. The subsoil generally has a very low supply of phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In years of below normal rainfall this soil is droughty because of the sand and gravel substratum. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIs.

309B—Allendorf silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on stream terraces. Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark gray, friable silty clay loam about 9 inches thick. The subsurface layer is dark brown, friable silty clay loam about 4 inches thick. The subsoil is about 26 inches thick. The upper part is brown, friable silty clay loam; the next part is dark yellowish brown, friable silty clay loam; and the

Figure 6.—An area of Omadi silty clay loam, 0 to 2 percent slopes, where floodwater from the Little Sioux River has recently deposited sediments.

lower part is dark yellowish brown and yellowish brown, friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, calcareous gravelly loamy sand. In some places the coarse textured substratum material is at a depth of less than 32 inches. In some places the surface layer and subsoil are loam.

Permeability in the Allendorf soil is moderate in the solum and very rapid in the substratum. Runoff is medium. Available water capacity is moderate. The subsoil generally has a very low supply of phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In years of below normal rainfall this soil is droughty because of the sand and gravel substratum. If cultivated crops are grown, erosion

is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, the cuts should not expose the sand and gravel substratum because it is low in fertility and difficult to till. Returning as much topsoil as possible helps in revegetating the site. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

310—Galva silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad flats and convex ridgetops in the uplands. Areas range from 5 to 60 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 28 inches thick. The upper and middle parts are brown silty clay loam; and the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some places the depth to firm clay loam or friable loam glacial till is less than 40 inches. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Galva soil is moderate, and runoff is slow. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is I.

310B—Galva silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 400 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 9 inches thick. The subsoil is friable and about 28 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 65 inches is yellowish brown, mottled, calcareous silt loam and clay loam. In some places depth to firm clay loam or friable loam glacial till is less than 40 inches. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture (fig. 7). If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

310B2—Galva silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish

Figure 7.—Bales of alfalfa hay on Galva silty clay loam, 2 to 5 percent slopes.

brown, friable silty clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil with the surface layer. The subsoil is friable and about 33 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In places firm clay loam or friable loam glacial till is at a depth of less than 40 inches. In some places the surface layer is more than 8 inches thick. In places in the southwestern part of the county, this soil is calcareous within a depth of 24 inches.

Permeability of this Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are

grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Galva soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

310C—Galva silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 60 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown and dark brown, friable silty clay loam about 7 inches thick. The subsoil is friable and about 27 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some places the surface layer is less than 8 inches thick and is mixed with brown subsoil. In some places firm clay loam or friable loam glacial till is at a depth of less than 40 inches.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

310C2—Galva silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is friable and about 32 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In some places firm clay loam or friable loam glacial till is at a depth of less than 40 inches. In some places the surface layer is more than 8 inches thick. In places in the southwestern part of the county, this soil is calcareous within a depth of 24 inches. In some places the substratum is grayish brown.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Galva soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

310D2—Galva silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes in the uplands. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is friable and about 32 inches thick. The upper and middle parts are brown silty clay loam; the lower part is brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous silt loam. In places it is calcareous within a depth of 24 inches. In other places the substratum is grayish brown.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Galva soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

354—Aquolls, ponded. This nearly level, very poorly drained soil is in depressional areas on bottom land and stream terraces adjacent to major streams and rivers. It is subject to ponding. Areas range from 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black silty clay loam or clay loam about 10 inches thick. The subsurface layer is black, very dark gray, or dark gray silty clay loam, clay loam, loam, or sandy loam about 30 inches thick. The substratum to a depth of about 60 inches is very dark gray, dark gray, or gray silty clay loam, clay loam, loam, sandy loam, or loamy sand.

Permeability in the soil varies, but generally is moderately slow, slow, or very slow. Available water capacity generally is moderate or high. In most areas either ponds are evident or the water table is at or near the surface throughout the year.

Most areas are idle or are used as wildlife habitat. This soil generally is unsuited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is better suited to use as habitat for wetland wildlife. Providing adequate drainage is very difficult because suitable outlets are not available.

A land capability classification has not been assigned.

428B—Ely silty clay loam, 1 to 4 percent slopes. This gently sloping, somewhat poorly drained soil is on slightly concave foot slopes and alluvial fans. Areas range from 5 to 30 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable silty clay loam about 20 inches thick. The subsoil is mottled, friable silty clay loam about 18 inches thick. The upper part is dark grayish brown and olive brown, and the lower part is brown. The substratum to a depth of about 60 inches is mottled brown, strong brown, and grayish brown silty clay loam.

Permeability in the Ely soil is moderate, and runoff is medium. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in siltation and gullying. Measures to control runoff on the soils upslope are needed. Grassed waterways help to remove excess water and prevent gullying. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface and crop rotations that include meadow crops help to prevent excessive soil loss. A drainage system will lower the seasonal high water table and improve the timeliness of field operations. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to

prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

433D—Storden loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 12 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable, calcareous loam about 4 inches thick. The subsurface layer is dark grayish brown, friable, calcareous loam about 7 inches thick. The next layer is brown and yellowish brown, friable, calcareous loam about 8 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. It contains pebbles throughout.

Permeability in the Storden soil is moderate, and runoff is medium. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil is suited to corn, soybeans, and small grain but is better suited to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose glacial till. However, as little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Also, returning as much topsoil as possible helps in revegetating the site. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

433F—Storden loam, 14 to 25 percent slopes. This moderately steep and steep, well drained soil is on convex side slopes in the uplands. Areas range from 10 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable, calcareous loam about 4 inches thick. The subsurface layer is dark grayish brown, friable, calcareous loam about 5 inches thick. The next layer is brown and yellowish brown, friable, calcareous loam about 8 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. It contains pebbles throughout.

Permeability in the Storden soil is moderate, and runoff is rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. This soil generally is unsuited to corn, soybeans, and small grain because the slope restricts the use of farm machinery and erosion is a hazard. The soil is better suited to grasses and legumes for hay and pasture.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIe.

433G—Storden loam, 25 to 50 percent slopes. This very steep, well drained soil is on convex side slopes in the uplands. Catsteps are common in areas of this Storden soil (fig. 8). Areas range from 10 to more than 300 acres in size and are long and irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable, calcareous loam about 4 inches thick. The subsurface layer is dark grayish brown, friable, calcareous loam about 5 inches thick. The next layer is brown and yellowish brown, friable, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. It contains pebbles throughout. In places it is clay loam. In places on escarpments slopes are more than 60 percent.

Included with this soil in mapping are small scattered areas where large stones eroded from the glacial till are on the surface. These areas are on the higher part of side slopes, and make up less than 5 percent of the unit.

Figure 8.—Catsteps in an area of Storden loam, 25 to 50 percent slopes.

Permeability in the Storden soil is moderate, and runoff is very rapid. Available water capacity is high. The substratum generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture or are left idle. This soil generally is unsuited to corn, soybeans, and small grain and to legumes for hay because the slope restricts the use of farm machinery and because erosion is a hazard. It is better suited to grasses for pasture. Many areas are in woodland or native prairie.

A cover of pasture plants is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

485—Spillville loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on bottom land and along intermittent streams. In some places it is on stream terraces and is subject to runoff from adjacent slopes. It is subject to flooding. Areas range from 4 to 50 acres in size. They are irregularly shaped on the bottom land of large streams and are long and narrow adjacent to intermittent streams.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable loam about 40 inches thick. The substratum to a depth of about 60 inches is dark brown loam.

Included with this soil in mapping are some areas of stratified, recently deposited alluvial sediments that have not been in place long enough for a soil profile to develop. The sediments typically are gravelly sand or loamy sand. These areas are at slightly lower elevations than the Spillville soil, and are adjacent to the stream channel. They make up less than 5 percent of the unit.

Permeability in the Spillville soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsurface layer generally has a very low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, the wetness caused by flooding is a hazard. Most periods of flooding are brief and occur before row crops are planted. Flood-protection measures are beneficial in some areas. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

485B—Spillville loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on linear to slightly concave foot slopes along narrow upland drainageways and on linear to slightly convex alluvial fans and stream terraces. Areas range from 2 to 10 acres in size and generally are long and narrow.

Typically, the surface layer is black, friable loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable loam about 38 inches thick. The substratum to a depth of about 60 inches is dark brown loam.

Permeability in the Spillville soil is moderate, and runoff is medium. The soil has a seasonal high water table. Available water capacity is high. The subsurface layer has a very low supply of available phosphorus and potassium.

Most areas are cultivated. Some are in pasture. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In some areas runoff from soils upslope results in siltation and gullying. Measures to control runoff on the soils upslope are needed. If cultivated crops are grown, erosion is a hazard. A system of conservation tillage that leaves crop residue on the surface, crop rotations that include meadow crops, and grassed waterways help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

505—Sperry silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in concave depressions on loess-covered stream terraces and uplands. It is subject to ponding. Areas range from 2 to 7 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 6 inches thick. The subsurface layer is about 12 inches thick. The upper part is black, friable silty clay loam; the lower part is grayish brown, light brownish gray, and light gray, mottled, friable silt loam. The subsoil is about 32 inches thick. The upper part is dark gray, mottled, friable silty clay loam; the next part is dark gray, mottled, firm silty clay loam; the lower part is dark grayish brown and grayish brown, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam.

Included with this soil in mapping is one area where clay loam glacial till is at a depth of 20 to 40 inches. Also, in this same area, gypsum occurs throughout the soil profile. This area is in sections 3 and 10 of Marcus Township.

Permeability in the Sperry soil is slow, and runoff is ponded. The soil has a seasonal high water table. Available water capacity is high. The subsoil generally has a low supply of available phosphorus and potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Crops are subject to damage by ponded water. Installation of a drainage system will improve drainage and provide good aeration and a deep root zone for plants. Tile drains and surface

intakes work well if they are properly installed and if an adequate outlet is available. Timely field operations are important in maintaining good tilth. Returning crop residue to the surface, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIw.

577B2—Everly clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on convex ridgetops and side slopes in the uplands. Areas range from 5 to 25 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil with the surface layer. The subsoil is about 32 inches thick. The upper part is brown, friable clay loam; the next part is yellowish brown, mottled, firm clay loam; the lower part is mottled yellowish brown, gray, and strong brown, firm clay loam. The substratum to a depth of about 60 inches is mottled yellowish brown, gray, and strong brown clay loam. In places this soil is calcareous within a depth of 24 inches.

Permeability in the Everly soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Everly soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

577C—Everly clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes in the uplands. Areas range from 5 to 25 acres in size and are irregularly shaped.

Typically, the surface layer is black, friable clay loam about l0 inches thick. The subsurface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is brown and dark brown, friable clay loam; the next part is yellowish brown, mottled, firm clay loam; and the lower part is mottled yellowish brown, gray, and strong brown, firm clay loam. The substratum to a depth of about 60 inches is mottled yellowish brown, gray, and strong brown clay loam.

Permeability in the Everly soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to control erosion. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

577C2—Everly clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands.

Areas range from 5 to 20 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is about 32 inches thick. The upper part is brown, friable clay loam; the next part is yellowish brown, mottled, firm clay loam; the lower part is mottled yellowish brown, gray, and strong brown, firm clay loam. The substratum to a depth of about 60 inches is mottled yellowish brown, gray, and strong brown clay loam. In places this soil is calcareous within a depth of 24 inches.

Permeability in the Everly soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to control erosion. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Everly soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

577D2—Everly clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes and shoulders of narrow interfluves in the uplands. Areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable clay loam about 8 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is about 30 inches thick. The upper part is brown, friable clay loam; the next part is yellowish brown, mottled, firm clay loam; the lower part is mottled yellowish brown, gray, and strong brown, firm clay loam. The substratum to a depth of about 60 inches is mottled yellowish brown, gray, and strong brown clay loam. In places this soil is calcareous within a depth of 24 inches.

Permeability in the Everly soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium.

Some areas are cultivated. Other areas are in pasture. In most areas this soil is managed along with adjacent soils. It is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. If terraces are built, cuts may expose the underlying glacial till. As little glacial till as possible should be exposed because it is low in fertility and not easily tilled. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Everly soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

585B—Spillville-Coland complex, 1 to 5 percent slopes. These gently sloping soils are on the lower part of narrow upland drainageways. The moderately well drained Spillville soil is on foot slopes between the Coland soil and the higher-lying soils on the adjacent hillsides. The poorly drained Coland soil is near the drainageways and is subject to flooding. Areas of these soils range from about 5 to 30 acres in size and are long and narrow. They are about 60 percent Spillville soil, 30 percent Coland soil, and 10 percent other soils. These soils are so intricately mixed or so narrow in size that mapping them separately is impractical.

Typically, the surface layer of the Spillville soil is

black, friable loam about 8 inches thick. The subsurface layer is black and very dark grayish brown, friable loam about 40 inches thick. The substratum to a depth of about 60 inches is dark brown loam. In some places the surface soil is less than 36 inches thick.

Typically, the surface layer of the Coland soil is black, friable clay loam about 8 inches thick. The subsurface layer is black and very dark gray, friable clay loam about 36 inches thick. The lower part is mottled. The substratum to a depth of about 60 inches is dark gray, mottled clay loam.

Included with this soil in mapping are some areas of stratified, recently deposited alluvial sediments that have not been in place long enough for a soil profile to develop. These areas are at slightly higher elevations than the Coland soil. They make up less than 10 percent of the unit.

Permeability in the Spillville and Coland soils is moderate. Runoff is medium on the Spillville soil and slow on the Coland soil. These soils both have a seasonal high water table. Available water capacity is high. The subsurface layers generally have a very low or medium supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture, but a few are cultivated. These soils are suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture, but are better suited to pasture. Many areas are in deep narrow valleys and are near soils on adjacent hillsides that are not commonly cropped because of steepness of slope. Access to these areas with farm machinery is difficult. If cultivated crops are grown, the seasonal high water table and flooding are hazards, especially in areas that receive runoff from adjacent uplands. A properly installed drainage system will improve drainage and provide good aeration and a deep root zone for plants. Some areas receive runoff from side slopes, and are subject to siltation. Conservation practices to control runoff on the soils upslope are needed. In some areas flood-protection measures are not practical. Good tilth generally can be easily maintained. Returning crop residue to these soils, regularly adding other organic material, and deferring tillage when the soils are wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIw.

633G—Steinauer-Steinauer Variant clay loams, 20 to 50 percent slopes. These steep and very steep soils are on side slopes in the uplands. The well drained Steinauer soil is on convex or linear side slopes. The poorly drained Steinauer Variant soil typically is on convex nose slope positions at elevations lower than the adjacent Steinauer soil. Areas of these soils range from 2 to 20 acres in size and are irregularly shaped. They are about 60 percent Steinauer soil and 40 percent Steinauer Variant soil. The two soils occur as areas so intricately mixed or so small in size that mapping them separately is impractical.

Typically, the surface layer of the Steinauer soil is very dark gray, friable, calcareous clay loam about 5 inches thick. Below that is a layer of yellowish brown and dark gray, firm, calcareous clay loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay loam. The soil contains pebbles throughout. In a few places the uppermost 12 to 24 inches of this soil is noncalcareous.

Typically, the surface layer of the Steinauer Variant soil is black and very dark brown, friable clay loam about 7 inches thick. The subsurface layer is about 9 inches thick. The upper part is very dark grayish brown, mottled, friable clay loam; the lower part is very dark grayish brown, mottled, friable clay. The subsoil is very firm and calcareous to a depth of about 60 inches. The upper part is grayish brown, mottled silty clay; the next part is light brownish gray, mottled silty clay; the lower part is grayish brown, mottled clay.

Included with these soils in mapping are scattered areas where large stones eroded from the glacial till are on the surface. These areas are on the higher part of side slopes, and make up less than 5 percent of the unit.

Permeability is moderately slow in the Steinauer soil and very slow in the Steinauer Variant soil. Runoff is very rapid in both soils. Available water capacity is high. The substratum of the Steinauer soil and the subsoil of the Steinauer Variant soil generally have a very low supply of available phosphorus and a very low or low supply of available potassium. In many areas soil slippage occurs during periods of above normal rainfall and saturated soil conditions (fig. 9). Most of the downward movement of soil material occurs in areas adjacent to the Steinauer Variant soil. The difference in clay content and permeability rate between the Steinauer and Steinauer Variant soils contributes to the instability during saturated conditions. The subsoil of the Steinauer Variant soil has a high shrink-swell potential,

Figure 9.—Soil slippage in an area of Steinauer-Steinauer Variant clay loams, 20 to 50 percent slopes.

which can damage roads, building foundations, and other structures.

Most areas are in pasture. These soils are unsuited to corn, soybeans, and small grain and to legumes for hay because the slope restricts the use of farm machinery and because erosion is a hazard. The soils are better suited to grasses for pasture.

A cover of pasture plants is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

739G—Steinauer-Hawick complex, 25 to 40 percent slopes. These very steep, well drained and excessively drained soils are on side slopes in the uplands and on stream terraces. The Steinauer soil is on the lower side slopes, and the Hawick soil is on the higher side slopes. Areas of these soils range from 2 to 20 acres in size and are irregularly shaped. They are about 65 percent Steinauer soil and 35 percent Hawick soil. These soils are so intricately mixed or so narrow in size that mapping them separately is impractical.

Typically, the surface layer of the Steinauer soil is very dark gray, friable, calcareous clay loam about 5 inches thick. Below that is a layer of yellowish brown and dark gray, firm, calcareous clay loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous clay

loam. The soil contains pebbles throughout.

Typically, the surface layer of the Hawick soil is black, very friable sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown, loose sandy loam about 4 inches thick. The subsoil is brown, loose, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, light yellowish brown, and pale brown, calcareous gravelly sand and very gravelly coarse sand.

Permeability is moderately slow in the Steinauer soil and very rapid in the Hawick soil. Runoff is very rapid. Available water capacity is high in the Steinauer soil and very low in the Hawick soil. The subsoil of the Steinauer and Hawick soils generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. These soils are unsuited to corn, soybeans, and small grain and to legumes for hay because the slope restricts the use of farm machinery and because erosion is a hazard. Also, the Hawick soil is very droughty. It is better suited to grasses for pasture.

A cover crop of pasture plants is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

740C—Hawick sandy loam, 2 to 9 percent slopes. This gently sloping to moderately sloping, excessively drained soil is on side slopes of stream terraces and on upland knobs. Areas range from 2 to 10 acres in size and are irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown, loose sandy loam about 5 inches thick. The subsoil is brown, loose, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, light yellowish brown, and pale brown, calcareous gravelly sand and gravelly coarse sand.

Permeability in the Hawick soil is very rapid, and runoff is medium. Available water capacity is very low. The subsoil generally has a very low supply of available phosphorous and potassium.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. Some areas are near soils that are well suited to crops. Some areas of this Hawick soil are cropped with those soils, and some are left in forage grasses for use as wildlife habitat or for grazing after harvest. Drought and erosion limit crop production. Pasture and hay help to control erosion. A system of conservation tillage that leaves crop residue on the surface or regular additions of other organic material improve fertility, help to conserve moisture, and maintain good tilth.

On pasture, overgrazing limits forage production because of low available water capacity. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IVs.

740E—Hawick sandy loam, 9 to 18 percent slopes. This strongly sloping and moderately steep, excessively drained soil is on side slopes of stream terraces and on upland knobs. Areas range from 2 to 10 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown, loose sandy loam about 5 inches thick. The subsoil is brown, loose, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, light yellowish brown, and pale brown, calcareous gravelly sand and gravelly coarse sand.

Included with this soil in mapping are areas of finer textured material on the lower part of the slope. They are stratified silt loam, silty clay loam, loam, and sandy loam. These areas make up less than 5 percent of the unit.

Permeability in the Hawick soil is very rapid, and runoff is medium or rapid. Available water capacity is very low. The subsoil generally has a very low supply of available phosphorous and potassium.

Most areas are in pasture. This soil generally is unsuited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay and pasture. Some areas are near soils that are suited to crops. Some areas of the Hawick soil are cropped with those soils, and some are left in forage grasses for use as wildlife habitat or for grazing after harvest. Drought and erosion limit crop production. Pasture and hay help to control erosion. A system of conservation tillage that leaves crop residue on the soil or regular additions of other organic material improve fertility and help to maintain good tilth.

On pasture, overgrazing limits forage production because of low available water capacity. Proper stocking rates, pasture rotation, and timely deferment of

grazing help to keep the pasture in good condition.

The land capability classification is VIs.

740G—Hawick sandy loam, 18 to 35 percent slopes. This steep and very steep, excessively drained soil is on side slopes on stream terraces. Areas range from 2 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, very friable sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown, loose sandy loam about 4 inches thick. The subsoil is brown, loose, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, light yellowish brown, and pale brown, calcareous gravelly sand and gravelly coarse sand.

Included with this soil in mapping are some small areas of Storden and Steinauer soils. These soils have a texture, respectively, of loam and clay loam, and both formed in glacial till. They are in similar landscape positions, and make up less than 10 percent of the unit.

Permeability in the Hawick soil is very rapid, and runoff is rapid or very rapid. Available water capacity is very low. The subsoil generally has a very low supply of available phosphorous and potassium.

Most areas are in pasture. This soil is unsuited to corn, soybeans, and small grain and to legumes for hay mainly because the slope is very steep and erosion is a hazard. It is better suited to grasses for pasture.

Drought and erosion limit crop production. A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet or too dry, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Species that can grow well in a calcareous soil should be selected for planting. Proper stocking rates, pasture rotation, and timely deferment of grazing, especially during dry periods, help to keep the pasture in good condition.

The land capability classification is VIIs.

810—Galva silty clay loam, benches, 0 to 2 percent slopes. This nearly level, well drained soil is on broad, loess-covered stream terraces (fig. 10). Areas range from 3 to 40 acres in size and are long to broad, and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 10 inches thick. The subsurface layer is black and dark brown, friable silty clay loam about 13 inches thick. The subsoil is brown and yellowish brown, friable silty clay loam about 50 inches thick. The substratum to a depth of about 114 inches is brown silt loam. Stratified sand and gravel are below a depth of 114 inches.

Permeability in the Galva soil is moderate, and runoff is slow. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is I.

810B—Galva silty clay loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on broad, loess-covered stream terraces. Areas range from 5 to 20 acres in size and are long and irregularly shaped.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is very dark brown and very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is brown, friable silty clay loam about 43 inches thick. The substratum to a depth of 60 inches is brown silt loam. Stratified sand and gravel are below a depth of 87 inches.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and

Figure 10.—An area of Galva silty clay loam, benches, 0 to 2 percent slopes, on a loess-covered stream terrace in the foreground. Gently sloping Galva soils are on uplands in the background.

reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

810C2—Galva silty clay loam, benches, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes on broad, loess-covered stream terraces. Areas range from 3 to 10 acres in size and are long and narrow.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 7 inches thick. Plowing has mixed some of the brown subsoil into the surface layer. The subsoil is brown, friable silty clay loam about 35 inches thick. The substratum to a depth of about 70 inches is yellowish brown silt loam. Stratified sand and gravel are at depths of 40 inches to more than 70 inches.

Permeability in the Galva soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are cultivated. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Galva soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and

timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

878B—Ocheyedan loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex ridgetops in the uplands and on stream terraces. Areas range from 5 to 40 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsurface layer is dark brown, friable loam about 3 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable loam; the next part is brown and dark yellowish brown, sandy loam; the lower part is mottled yellowish brown and grayish brown, friable silt loam. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is mottled grayish brown and yellowish brown, and the lower part is grayish brown and has mottles.

Permeability in the Ocheyedan soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIe.

878C2—Ocheyedan loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes in the uplands and on stream terraces. Areas range from 2 to 15 acres in size and are irregularly shaped.

Typically, the surface layer is very dark grayish brown, friable loam about 8 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable loam; the next part is brown and dark yellowish brown, friable sandy loam; the lower part is mottled yellowish brown and grayish brown, friable silt loam. The substratum to a depth of about 60 inches is mottled grayish brown and yellowish brown, calcareous silt loam.

Permeability in the Ocheyedan soil is moderate, and runoff is medium. Available water capacity is high. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a hazard. Contour farming, terraces, a system of conservation tillage that leaves crop residue on the surface, and crop rotations that include meadow crops help to prevent excessive soil loss. Good tilth generally can be easily maintained. Returning crop residue to the soil, regularly adding other organic material, and deferring tillage when the soil is wet improve tilth and fertility, help to prevent surface crusting, and increase the rate of water infiltration. More nitrogen and more intensive management are needed on this soil than on the less eroded Ocheyedan soils.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is IIIe.

1609—Fluvaquents-Omadi complex, channeled, 0 to 2 percent slopes. These nearly level, moderately well drained to poorly drained soils are on bottom land along the major streams. The soils generally are dissected by many old stream channels. Fluvaquents are on old meandering channels, low natural levees, sloughs, small oxbows, and sandbars. They are lower on the landscape, and are subject to frequent flooding. The Omadi soil is on higher-lying areas, and is subject to occasional flooding. Areas range from 5 to 80 acres in size and are long and irregularly shaped. They are about 50 percent Fluvaquents, 40 percent Omadi soil, and 10 percent other soils. These soils are in areas so intricately mixed or so small in size that mapping them separately is impractical.

Typically, Fluvaquents are made up of sediments that vary in texture. They generally are silty and sandy, but thin layers of other textures are common.

Typically, the surface layer of the Omadi soil is very

dark gray, friable, calcareous silty clay loam about 14 inches thick. The next layer is very dark gray, friable, calcareous silty clay loam about 8 inches thick. The substratum to a depth of about 60 inches is multicolored, stratified, calcareous silt loam and silty clay loam. In some places after recent flooding, as much as 6 inches of overwash has been deposited.

Included with these soils in mapping are some areas of Colo soils. Colo soils are at slightly lower elevations and in some years have remained wet and delayed tillage. They make up less than 10 percent of the map unit.

Permeability of Fluvaquents varies with the many kinds of soil material that constitute them. Permeability of the Omadi soil is moderate, and runoff is slow. The Omadi soil has a seasonal high water table. Available water capacity is low in some areas of Fluvaquents and very high in the Omadi soil. In the Omadi soil the substratum generally has a low supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in timbered pasture and are used as wildlife habitat. These soils generally are unsuited to corn, soybeans, and small grain. The channels generally cannot be crossed by farm machinery because they are too deep and wet. These soils are better suited to water-tolerant plants and grasses and to trees that can tolerate some wetness.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth and reduces forage production. Proper stocking rates and controlled grazing during wet periods help to keep the pasture in a more productive condition.

The land capability classification is Vw.

1639G—Storden-Hawick complex, 25 to 50 percent slopes. These very steep, well drained and excessively drained soils are on side slopes in the uplands and on stream terraces. The Storden soil is on the lower side slopes, and the Hawick soil is on the higher side slopes. Areas range from 2 to 20 acres in size and are irregularly shaped. They are about 65 percent Storden soil and 35 percent Hawick soil. These soils are so intricately mixed or so narrow that mapping them separately is impractical.

Typically, the surface layer of the Storden soil is very dark grayish brown, friable, calcareous loam about 4 inches thick. The subsurface layer is dark grayish brown, friable, calcareous loam about 5 inches thick. The next layer is brown and yellowish brown, friable, calcareous loam about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled, calcareous loam. It contains pebbles throughout. In places it is clay loam. In places the soils on escarpments have slopes of more than 60 percent.

Typically, the surface layer of the Hawick soil is black, very friable sandy loam about 8 inches thick. The subsurface layer is very dark grayish brown, loose sandy loam about 4 inches thick. The subsoil is brown, loose, calcareous gravelly loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is yellowish brown, light yellowish brown, and pale brown, calcareous gravelly sand and gravelly coarse sand.

Permeability is moderate in the Storden soil and very rapid in the Hawick soil. Runoff is very rapid. Available water capacity is high in the Storden soil and very low in the Hawick soil. The substratum of the Storden soil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. The subsoil of the Hawick soil generally has a very low supply of available phosphorus and potassium.

Most areas are in pasture. These soils are unsuited to corn, soybeans, and small grain and to legumes for hay because the slope restricts the use of farm machinery and because erosion is a hazard. Also, the Hawick soil is very droughty. The soils are better suited to grasses for pasture.

A cover of pasture plants is effective in controlling erosion. Overgrazing or grazing during wet periods, however, causes surface compaction and poor tilth, increases the runoff rate, and reduces forage production. Planting species that grow well in calcareous soil provides the highest yields. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is VIIe.

1658C—Terril-Coland complex, channeled, 2 to 9 percent slopes. These gently sloping to moderately sloping soils are on the lower part of narrow upland drainageways. They generally are dissected by many old stream channels. The Coland soil is subject to flooding. The moderately well drained Terril soil is on foot slopes and alluvial fans between the Coland soil and the higher lying soils on the adjacent hillsides. The poorly drained Coland soil is near drainageways. Areas range from 5 to 40 acres in size and are long and narrow. They are about 50 percent Terril soil, 40 percent Coland soil, and 10 percent other soils. These soils are so intricately mixed or so narrow that mapping them separately is impractical.

Typically, the surface layer of the Terril soil is black, friable loam about 8 inches thick. The subsurface layer is black, very dark brown, and very dark grayish brown,

friable loam about 24 inches thick. The subsoil is friable loam and clay loam about 21 inches thick. The upper part is dark brown, and the lower part is brown and dark yellowish brown. The substratum to a depth of about 60 inches is brown and dark yellowish brown loam.

Typically, the surface layer of the Coland soil is black, friable clay loam about 8 inches thick. The subsurface layer is black and very dark gray, mottled, friable clay loam about 36 inches thick. The substratum to a depth of about 60 inches is dark gray, mottled clay loam.

Included with these soils in mapping are some small areas of the somewhat poorly drained Spillville soils. They are in landscape positions similar to those of the Coland soil. They make up less than 10 percent of the unit.

Permeability of these Terril and Coland soils is moderate. Runoff is medium in the Terril soil and slow in the Coland soil. Available water capacity is high. The subsoil of the Terril soil generally has a very low supply of available phosphorus and a very low or low supply of available potassium. The subsurface layer of the Coland soil generally has a medium supply of available phosphorus and a very low or low supply of available potassium.

Most areas are in pasture. These soils generally are unsuited to corn, soybeans, and small grain. The channels in the Coland soil generally cannot be crossed by farm machinery because they are too deep and wet. They are better suited to grasses and legumes for pasture. Good tilth generally can be easily maintained.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the rate of runoff, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is Vw.

1785—Spillco loam, channeled, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on bottom land and along intermittent streams. It is subject to flooding. It is dissected by many old stream channels. Areas range from 2 to 20 acres in size and generally are long and irregularly shaped.

Typically, the surface layer is very dark gray, friable loam about 9 inches thick. The subsurface layer is black, friable loam about 5 inches thick. The next layer is black, friable, calcareous loam about 29 inches thick. The substratum to a depth of about 60 inches is very dark gray, calcareous sandy loam. In some places this soil is calcareous to the surface, and in other places it is noncalcareous above a depth of 40 inches.

Included with this soil in mapping are some areas of stratified, recently deposited alluvial sediments that have not been in place long enough for a soil profile to develop. The sediments typically are gravelly sand or loamy sand. Areas of these sediments are at slightly lower elevations than the Spillco soil and are adjacent to the stream channel. They make up less than 10 percent of the unit.

Permeability in the Spillco soil is moderate, and runoff is slow. The soil has a seasonal high water table. Available water capacity is high. The subsurface layer generally has a low supply of available phosphorus and a very low supply of available potassium.

Most areas are in pasture. This soil generally is unsuited to corn, soybeans, and small grain. The channels generally cannot be crossed by farm machinery because they are too deep and wet. The soil is better suited to grasses and legumes for pasture. Good tilth generally can be easily maintained.

On pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth, increases the rate of runoff, and reduces forage production. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition.

The land capability classification is Vw.

5010—Pits, sand and gravel. This map unit consists of sand and gravel pits, on bottom land, stream terraces, and uplands, where sand and gravel have been removed. The pits are 5 to 30 feet deep. Many of these pits are still in operation, but others are no longer used as a source of sand and gravel. Individual areas range from 5 to more than 20 acres in size and are irregularly shaped.

The soil materials in Pits, sand and gravel, are quite variable. In general, permeability is moderately rapid to very rapid. Available water capacity is low. Some of the inactive pits are filled with water. Most pits have vertical sides that support little or no vegetation. The bottoms of most pits generally support some vegetation, and are suited to use as wildlife habitat.

A land capability classification has not been assigned.

5040—Orthents, loamy. These nearly level to strongly sloping soils are on uplands and stream terraces. They are borrow areas for construction, cut and fill areas, sanitary landfills, and reclaimed gravel pits (fig. 11). In some areas the original soils have been removed to a depth of 5 to 30 feet or more, and in other

Figure 11.—Spring Lake Park, which is a reclaimed gravel pit.

areas 4 to 10 inches of topsoil has been redistributed, commonly in an uneven pattern. The soils range from excessively drained to somewhat poorly drained, depending on the kind of material from which the soils were derived and the extent to which the borrow area is restored. Areas typically range from 6 to 50 acres in size. They are commonly square or rectangular, but some are irregularly shaped.

Typically, the uppermost 60 inches is yellowish brown, friable and firm clay loam, loam, or silt loam. In many places cobbles and pebbles are common on the surface. In some places the texture is sandy loam. The surface color ranges from very dark gray to dark brown.

Included with these soils in mapping are areas covered by streets, parking lots, buildings, and other structures that so obscure or alter the soils that identification of the soil series is not feasible. Also included are a few areas of dumps that have been covered.

Permeability in Orthents varies with texture and density. Available water capacity is moderate or low. Soil material now at the surface was once buried 5 to 20 feet or more beneath the surface. It has less pore space and a higher density than the original surface layer. It has not been appreciably affected by the processes of soil formation, such as freezing and thawing. Surface runoff is slow to rapid. Unless the topsoil has been redistributed throughout the area,

preparing a good seedbed is difficult and drought is a hazard. In most areas these soils have a very low supply of available phosphorus and potassium.

These soils are better suited to small grain and to grasses and legumes for hay and pasture than to row crops. They are suited to row crops only in some areas where the topsoil has been redistributed. Corn and soybeans are grown in these areas. If cultivated crops are grown, erosion is a moderate or severe hazard in the more sloping areas. A conservation tillage system that turns over as little of these soils as possible and leaves crop residue on the surface helps to control erosion and stabilize the soils.

A land capability classification has not been assigned.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 260,000 acres in the survey area, or nearly 71 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in the northern part, mainly in associations 1, 2, and 5, which are described under the heading "General Soil Map Units." About 248,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly corn and soybeans, account for an estimated three-fourths of the county's total agricultural income each year.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

According to the 1985 State of Iowa Annual Farm Census, 285,500 acres in Cherokee County is used for cultivated crops and 59,600 acres is used for pasture. The main crops are corn, soybeans, oats, and legume-grass hay. The paragraphs that follow describe the management concerns affecting the use of the soils in the county for crops and pasture. These concerns are water erosion, soil blowing, drainage, soil fertility, and soil tilth.

Water erosion is a major problem on more than 67 percent of the cropland and pasture in the county. Measures to control erosion are needed on Allendorf, Dickman, Ely, Estherville, Everly, Galva, Hawick, Ida, Judson, Ocheyedan, Primghar, Sac, Spillville, Steinauer, Storden, Terril, and Wadena soils.

Loss of the surface layer through erosion reduces the productivity of soils and results in sedimentation in streams. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils having a subsoil that is low in fertility, such as Galva and Sac soils. Erosion also reduces the productivity of soils that tend to be droughty, such as Allendorf, Dickman, Estherville, Hawick, and Wadena soils. Control of erosion, by minimizing the pollution of streams, helps to maintain the productivity of soils and improves the quality of water for municipal use, for recreation, and for fish and other kinds of wildlife.

Timely field operations help to maintain good tilth on

soils with a surface texture of silty clay loam. Deferring tillage on these soils, such as Colo and Marcus soils, when they are wet, prevents cloddiness and helps in preparing a good seedbed.

Measures to control erosion, such as providing a protective plant cover, can also reduce runoff and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface can reduce soil losses to an amount that will not decrease the productive capacity of the soils. On livestock farms, where part of the acreage is hayland, including grasses and legumes in the cropping system provides nitrogen and improves tilth for the following crops and helps to control water erosion on the more sloping soils.

A system of conservation tillage that leaves crop residue on the surface is effective in controlling erosion. Examples of major conservation tillage systems include: no-till or slot tillage; strip-till; ridge-till; and mulch-till. In no-till or slot tillage, preparation of the seedbed and planting are completed in one operation. Little or no soil is disturbed except in the immediate area of the planted seed row. Soil disturbance is 10 percent or less.

In strip-till, as in the no-till system, seedbed preparation and planting are completed in one operation. Tillage in the row is limited to a strip not wider than a third of the total area. A protective cover of crop residue is left on two-thirds of the soil surface.

In ridge-till, seedbed preparation and planting are completed in one operation. Planting is completed on ridges generally 4 to 6 inches higher than row middles. Approximately one-third of the soil surface is tilled at planting time with sweeps or row cleaners. This system offers several advantages on such poorly drained soils as Marcus soils.

In mulch-till, the soil is loosened over the entire surface with tillage tools, such as chisels, field cultivators, and disks. Residue is partly incorporated into the soil surface. Seedbed preparation and planting may be accomplished in one operation or in separate operations. Conservation tillage is not effective unless enough residue is left on the soil surface after planting to adequately control erosion.

Use of the soil for pasture is also an effective means of controlling erosion (fig. 12). Maximum grass and legume production can be achieved by correct soil treatment and proper use of pasture and hay. Proper management practices for established stands include adequate fertilization, weed and brush control, rotation grazing, deferred grazing where full-season grazing systems are used, proper stocking rates, and adequate livestock watering facilities. Erosion is a severe hazard if the vegetative cover is destroyed in renovating sloping pastureland and hayland. If cultivated crops are grown before seeding to pasture plants, conservation tillage, contour farming, and grassed waterways help to control soil losses. In addition, interseeding grasses and legumes into the existing sod prevents the destruction of the existing vegetative cover in seedbed preparation.

Terraces and diversions reduce the length of slopes and thus the runoff rate and risk of erosion. They are most practical on deep, well drained soils that have long, uniform slopes. In many areas of Galva and Sac soils, terracing is a suitable management practice. When terracing in areas where loess is thin, as in Sac soils, the underlying, less productive glacial till should not be exposed because it is not fertile and is difficult to till. Because of wetness, tile inlet terraces are beneficial when tilling in waterways in soils such as Colo-Judson silty clay loams. Tile inlet terraces are also advantageous on Sac soils because of the slowly permeable underlying glacial till. Terracing is not practical on Dickman, Estherville, and Hawick soils or in most places on Allendorf and Wadena soils because terrace cuts expose the coarse textured, unproductive material. On these soils, a cropping system that provides a substantial plant cover and a system of conservation tillage that leaves crop residue on the surface are effective in controlling erosion.

Contour farming and contour stripcropping help to control erosion on many soils in the county. They are most effective in areas where slopes are smooth and uniform, including most areas of Galva and Sac soils.

Soil blowing is a hazard on Dickman and Hawick soils, which are sandy. Soil blowing can damage these soils in a few hours and damage seedlings on these and adjacent soils. A plant cover, surface mulch, or tillage methods that keep the surface rough help to control soil blowing.

Gully control structures, grassed waterways, and farm ponds are used in controlling erosion in watercourses. Farm ponds also provide a supply of water for livestock and for recreation.

Information on the design of erosion control practices for each kind of soil can be found in the Technical Guide, which is available at local offices of the Soil Conservation Service.

Soil drainage is a major management concern in Cherokee County. Very poorly drained to somewhat poorly drained soils make up about 23 percent of the total acreage. On Coland, Colo, and Zook soils, artificial drainage is needed.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drains or a system that controls runoff from the

Figure 12.—A pastured area of moderately sloping to steep Steinauer soils. The cover of pasture plants and the pond help to control erosion.

slopes at higher elevations and drainage tile are needed in most areas of the somewhat poorly drained and poorly drained soils that are intensively row cropped. Drains should be more closely spaced in the moderately slowly permeable soils than in the more rapidly permeable soils.

Information on design of drainage systems for each kind of soil is contained in the Technical Guide, which is available in local offices of the Soil Conservation Service.

Soil fertility is naturally low or very low in most soils in Cherokee County because in most soils the subsoil is low or very low in available phosphorus and potassium. Most upland soils are slightly acid in the surface layer and require applications of lime to raise the pH level sufficiently for good growth of alfalfa and other crops. For these crops, nearly neutral soils are needed for high production. On eroded soils, organic matter content is lower and hence natural fertility is less in the surface layer than on noneroded soils of the same series.

Applications of lime and fertilizer should be based on the results of soil tests, on the needs of the intended crop, and on the expected level of yields. The Cooperative Extension Service can provide help in determining the kinds of amounts needed.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous.

Most of the soils used for crops in the survey area

have a surface layer of silty clay loam that is dark and moderate in content of organic matter. On moderately eroded soils, like Galva and Sac soils, the surface layer is lower in organic matter content and higher in clay content than on the uneroded phase. Generally, the structure of such soils is weak and intense rainfall causes the formation of crust on the surface. A crust is hard when dry and nearly impervious to water. If a crust forms, it reduces infiltration and increases runoff. Regular additions of crop residue, manure, and other organic material help to improve soil structure and reduce crust formation.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be

partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, reduce energy requirements, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after

rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, orchardgrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and elderberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are

texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl-feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial

buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of calcium carbonate affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent,

surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index

properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, and bedrock.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce water erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

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Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

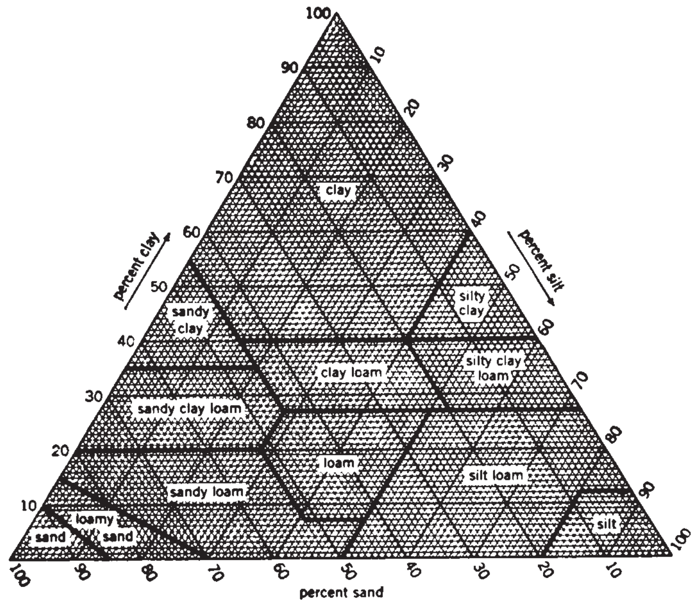

Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and

clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberglimits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous, loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained

sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the

soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

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Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(21)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual (20)*. Many of the technical terms used in the descriptions are defined in *Soil Taxonomy (21)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Afton Series

The Afton series consists of poorly drained, moderately slowly permeable soils in drainageways on uplands. These soils formed in loess and alluvium derived from loess. Native vegetation was mixed prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Afton silty clay loam, 0 to 2 percent slopes, in cropland; 680 feet north and 170 feet west of the southeast corner of sec. 17, T. 93 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium clods parting to weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

A1—8 to 16 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—16 to 23 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; gradual smooth boundary.

AB—23 to 31 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct olive gray (5Y 4/2) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

Bg1—31 to 37 inches; dark grayish brown (2.5Y 4/2) silty clay loam; discontinuous black (10YR 2/1) coatings on faces of peds; common fine faint dark gray (5Y 4/1) and olive brown (2.5Y 4/4) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

Bg2—37 to 41 inches; gray (5Y 5/1) and olive brown (2.5Y 4/4) silty clay loam; common fine faint dark gray (5Y 4/1) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; few soft black (10YR 2/1) concretions (manganese oxides); neutral; clear smooth boundary.

Bg3—41 to 47 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) and common fine faint dark gray (5Y 4/1) mottles; weak medium subangular blocky structure; friable; few soft black (10YR 2/1) and dark brown (7.5YR 3/4) concretions (manganese and iron oxides); mildly alkaline; abrupt smooth boundary.

Cg—47 to 60 inches; mottled olive gray (5Y 5/2) and yellowish brown (10YR 5/6) silt loam; massive; friable; few soft black (10YR 2/1) and dark brown (7.5YR 3/4) concretions (manganese and iron oxides); common white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 40 to 55 inches in thickness. The depth to free carbonates ranges from 38 to 55 inches. The mollic epipedon is 24 to 32 inches thick.

The A horizon has value of 2 or 3. It is silty clay loam that is typically 30 to 37 percent clay. The Bg horizon has chroma of 2 or less. The Cg horizon has chroma of 1 to 3. Some pedons have a 2Cg horizon. It is loam or clay loam glacial till at a depth of more than 50 inches.

Allendorf Series

The Allendorf series consists of well drained soils on stream terraces. These soils formed in loess or silty alluvium over sand and gravel. Permeability is moderate over very rapid. Native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Allendorf silty clay loam, 2 to 5 percent slopes, in oats; 1,640 feet west and 560 feet south of the northeast corner of sec. 7, T. 93 N., R. 40 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; nearly continuous black (10YR 2/1) coatings on faces of peds; moderate medium clods parting to weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A—9 to 13 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure; friable; common very dark gray (10YR 3/1) channel fillings; slightly acid; clear smooth boundary.

Bw1—13 to 23 inches; brown (10YR 4/3) silty clay loam; common discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—23 to 29 inches; dark yellowish brown (10YR 4/4) silty clay loam; common discontinuous dark brown (10YR 3/3) coatings on faces of peds; moderate medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw3—29 to 35 inches; dark yellowish brown (10YR 4/4)

silty clay loam; common discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

2BC—35 to 39 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) sandy loam; weak fine subangular blocky structure; friable; few fine light gray (10YR 7/1) accumulations (calcium carbonate); about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

2C—39 to 60 inches; yellowish brown (10YR 5/4) gravelly loamy sand; single grained; loose; about 30 percent gravel; slight effervescence; mildly alkaline.

Solum thickness and depth to free carbonates typically range from 30 to 40 inches. The silty material is about 30 to 36 inches thick. It typically contains 5 to 15 percent total sand, most of which is fine or very fine.

The A horizon has value of 2 or 3. The Bw horizon has value of 4 or 5. The 2C horizon has value of 4 to 6 and chroma of 3 to 6. It commonly is gravelly loamy sand to gravelly sand, but ranges to loamy sand or sand.

Coland Series

The Coland series consists of poorly drained, moderately permeable soils on bottom land. These soils formed in loamy alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Coland clay loam, 0 to 2 percent slopes, in cropland; 1,480 feet east and 125 feet north of the southwest corner of sec. 6, T. 93 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A1—8 to 22 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A2—22 to 36 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

AC—36 to 44 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; discontinuous black (5Y 2/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/6) and few fine faint dark reddish brown (5YR 3/2) mottles; weak medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—44 to 60 inches; dark gray (5Y 4/1) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure grading to massive in lower part; friable; few soft black (10YR 2/1) concretions (manganese oxides); neutral.

Thickness of the solum and that of the mollic epipedon range from 36 to 48 inches.

The A horizon has value of 2 or 3. It commonly is clay loam, but ranges to silty clay loam. The Cg horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 or 2.

Colo Series

The Colo series consists of poorly drained, moderately permeable soils on bottom land and in drainageways on uplands. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, in pasture; 1,240 feet south and 120 feet east of the northwest corner of sec. 35, T. 93 N., R. 42 W.

A1—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A2—9 to 15 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure parting to weak moderate fine granular; friable; neutral; gradual smooth boundary.

A3—15 to 21 inches; black (N 2/0) silty clay loam, black(10YR 2/1) dry; weak fine subangular blocky structure parting to weak medium and fine granular; friable; neutral; gradual smooth boundary.

A4—21 to 29 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure parting to weak medium and fine granular; friable; neutral; gradual smooth boundary.

A5—29 to 40 inches; black (5Y 2.5/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak medium and fine granular; friable; neutral; gradual smooth boundary.

AC—40 to 47 inches; very dark gray (5Y 3/1) silty clay loam, grayish brown (2.5Y 5/2) dry; few fine distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—47 to 60 inches; dark gray (5Y 4/1) silt loam; massive; friable; neutral.

The solum ranges from 36 to 60 inches in thickness. The mollic epipedon is 36 to more than 48 inches thick.

The A horizon has hue of 10YR to 5Y and value of 2 or 3. The Cg horizon has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 or 2. It typically is silt loam but ranges to include silty clay loam.

Dickman Series

The Dickman series consists of well drained, moderately rapidly permeable soils on stream terraces and uplands. These soils formed in loamy and sandy sediments deposited dominantly by water but, in some areas, by wind. Native vegetation was prairie grasses. Slopes range from 2 to 12 percent.

Typical pedon of Dickman sandy loam, 5 to 12 percent slopes, in cropland; 2,260 feet east and 280 feet north of the southwest corner of sec. 9, T. 93 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray(10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

A—8 to 16 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; neutral; clear smooth boundary.

Bw1—16 to 23 inches; brown (10YR 4/3) and dark brown (10YR 3/3) loamy sand; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium and fine granular structure; very friable; neutral; clear smooth boundary.

Bw2—23 to 32 inches; dark yellowish brown (10YR 4/4) loamy sand; weak very fine granular structure; very friable; mildly alkaline; abrupt smooth boundary.

C—32 to 60 inches; yellowish brown (10YR 5/4) sand; single grained; loose; violent effervescence; moderately alkaline.

The solum ranges from 24 to 36 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value of 4 or 5. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 3 or 4.

Ely Series

The Ely series consists of somewhat poorly drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in silty local alluvium derived from loess. Native vegetation was prairie grasses. Slopes range from 1 to 4 percent.

Typical pedon of Ely silty clay loam, 1 to 4 percent slopes, in cropland; 220 feet east and 140 feet north of the southwest corner of sec. 21, T. 91 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium clods parting to weak fine granular structure; friable; slightly acid; clear smooth boundary.

A1—8 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and very fine granular structure; friable; slightly acid; clear smooth boundary.

A2—14 to 28 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; moderate fine and very fine subangular blocky structure; friable; few black (10YR 2/1) channel fillings; dark yellowish brown (10YR 4/4) krotovinas; neutral; clear smooth boundary.

Bw1—28 to 33 inches; dark grayish brown (10YR 4/2) and olive brown (2.5Y 4/4) silty clay loam; few discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; few fine distinct strong brown (7.5YR 5/6) mottles; weak fine and very fine subangular blocky structure; friable; few black (10YR 2/1) channel fillings; neutral; gradual smooth boundary.

Bw2—33 to 46 inches; brown (10YR 4/3) silty clay loam; few fine distinct strong brown (7.5YR 5/6) and few fine faint grayish brown (10YR 5/2) mottles; weak medium and fine subangular blocky structure; friable; few black (10YR 2/1) channel fillings; very dark grayish brown (10YR 3/2) krotovinas; few black (10YR 2/1) concretions (manganese oxides); neutral; gradual smooth boundary.

C—46 to 60 inches; mottled brown (10YR 4/3), strong brown (7.5YR 5/6 and 4/6), and grayish brown (10YR 5/2) silty clay loam; massive; friable; common black (10YR 2/1) concretions (manganese oxides); neutral.

The solum typically ranges from 40 to more than 60 inches in thickness. The mollic epipedon ranges from 24 to 36 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. The C horizon is silt loam or silty clay loam.

Estherville Series

The Estherville series consists of somewhat excessively drained soils on valley trains and stream terraces. These soils formed in loamy material over sand and gravel. Permeability is moderately rapid over very rapid. Native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Estherville loam, 2 to 5 percent slopes, in oats; 420 feet west and 260 feet north of the southeast corner of sec. 2, T. 93 N., R. 41 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; few very dark brown (10YR 3/3) channel fillings; slightly acid; clear smooth boundary.

Bw—13 to 20 inches; dark yellowish brown (10YR 3/4) sandy loam; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

2C1—20 to 24 inches; brown (10YR 4/3) and dark brown (10YR 3/3) gravelly loamy sand; massive; loose; about 15 percent gravel; strong effervescence; mildly alkaline; clear smooth boundary.

2C2—24 to 60 inches; yellowish brown (10YR 5/4) and brown (10YR 5/3) gravelly coarse sand; single grained; loose; about 35 percent gravel; strong effervescence; moderately alkaline.

Solum thickness and depth to carbonates range from 15 to 30 inches.

The A horizon has chroma of 1 or 2. The Bw horizon has value and chroma of 3 or 4. It is sandy loam or loam. The 2C horizon has value of 4 to 6 and chroma of 3 to 5. It commonly is 10 to 35 percent gravel, by volume.

Everly Series

The Everly series consists of well drained, moderately permeable soils on ridgetops and side slopes in the uplands. These soils formed in loamy erosional sediments and the underlying glacial till. Native vegetation was prairie grasses. Slopes range from 2 to 14 percent.

Typical pedon of Everly clay loam, 5 to 9 percent slopes, in pasture; 1,740 feet south and 320 feet west of the northeast corner of sec. 18, T. 92 N., R. 40 W.

A1—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium and fine granular structure; friable; medium acid; clear smooth boundary.

A2—10 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; black (10YR 2/1) channel fillings; slightly acid; gradual smooth boundary.

BA—16 to 24 inches; brown (10YR 4/3) and dark brown (10YR 3/3) clay loam; weak medium subangular blocky structure parting to moderate fine subangular blocky; friable; neutral; clear smooth boundary.

2Bw1—24 to 35 inches; yellowish brown (10YR 5/4) clay loam; discontinuous brown (10YR 4/3) coatings on faces of peds; few fine distinct brown (7.5YR 4/4) and grayish brown (10YR 5/2) mottles in the upper part; weak medium prismatic structure parting to moderate fine subangular blocky; firm; few soft yellowish red (5YR 5/8) accumulations (iron oxides); neutral; abrupt smooth boundary.

2Bw2—35 to 39 inches; yellowish brown (10YR 5/4) clay loam; discontinuous brown (10YR 4/3) coatings on faces of peds; common medium distinct brown (7.5YR 4/4) and grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; firm; common white (10YR 8/2) nodules and few white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

2BC—39 to 42 inches; mottled yellowish brown (10YR 5/4), gray (10YR 5/1), and strong brown (7.5YR 5/6) clay loam; discontinuous brown (10YR 4/3) coatings on faces of peds; moderate medium and fine angular blocky structure; firm; common white (10YR 8/2) nodules and few soft white (10YR 8/2) accumulations (calcium carbonate); about 5 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

2C— 42 to 60 inches; mottled yellowish brown (10YR 5/4), gray (10YR 5/1), and strong brown (7.5YR 5/6) clay loam; discontinuous brown (10YR 4/3) coatings on faces of peds; massive; firm; common white (10YR 8/2) nodules and few soft white (10YR 8/2) accumulations (calcium carbonate); about 5 percent gravel; strong effervescence; moderately alkaline, gradual smooth boundary.

The solum typically ranges from 24 to 42 inches in

thickness. The sediment overlying the glacial till commonly is 24 to 30 inches thick, but ranges from 16 to 36 inches. These sediments typically do not have coarse fragments.

The 2Bw horizon has chroma of 3 or 4. The 2C horizon has value of 4 to 6 and chroma of 2 to 4. It typically has mottles that have hue of 10YR and 7.5YR, value of 4 to 6, and chroma of 1 to 6.

The Everly soils in map units 577B2, 577C2, and 577D2 are taxadjuncts to the Everly series because the dark colored surface soil is thinner than required for a mollic epipedon.

Galva Series

The Galva series consists of well drained, moderately permeable soils on broad flats, ridgetops, and side slopes in the uplands and on stream terraces. These soils formed in loess. Native vegetation was prairie grasses. Slopes range from 0 to 14 percent.

Typical pedon of Galva silty clay loam, 2 to 5 percent slopes, in cropland; 580 feet east and 200 feet north of the southwest corner of sec. 5, T. 93 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A—8 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

AB—12 to 17 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1—17 to 24 inches; brown (10YR 4/3) silty clay loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

Bw2—24 to 33 inches; brown (10YR 4/3) silty clay loam; discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure parting to weak fine subangular blocky; friable; neutral; gradual smooth boundary.

BC—33 to 45 inches; brown (10YR 4/3) silty clay loam; few fine faint grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few black (10YR 2/1) concretions (manganese oxides); neutral; gradual smooth boundary.

C1—45 to 60 inches; yellowish brown (10YR 5/4) silt loam; common fine distinct strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2) mottles; massive; friable; common black (10YR 2/1) concretions (manganese oxides); few white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline.

C2—60 to 65 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; massive; firm; few white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline.

Solum thickness and depth to free carbonates typically are 36 to 48 inches, but range from 32 to 55 inches.

The A horizon has chroma of 1 to 3. The Bw horizon has chroma of 3 or 4. The C horizon has value of 4 or 5. The 2C horizon is loam or clay loam. On stream terraces, stratified sand and gravel is at a depth of 40 to 120 inches.

The Galva soils in map units 310B2, 310C2, 310D2, and 810C2 are taxadjuncts to the Galva series because the dark colored surface soil is thinner than required for a mollic epipedon.

Hawick Series

The Hawick series consists of excessively drained, moderately rapidly over very rapidly permeable soils on side slopes of stream terraces and on upland knobs. These soils formed in loamy, sandy, and gravelly glacial deposits. Native vegetation was prairie grasses. Slopes range from 2 to 35 percent.

Typical pedon of Hawick sandy loam, 18 to 35 percent slopes, in pasture; 2,140 feet south and 750 feet west of the northeast corner of sec. 25, T. 93 N., R. 41 W.

A1—0 to 8 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; very friable; about 10 percent gravel; mildly alkaline; clear smooth boundary.

A2—8 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; loose; about 10 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw—12 to 18 inches; brown (10YR 4/3 and 5/3)

gravelly loamy sand; single grained; loose; few white (10YR 8/2) nodules (calcium carbonate); about 20 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

C1—18 to 33 inches; yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4) gravelly sand; single grained; loose; few white (10YR 8/2) nodules (calcium carbonate); about 20 percent gravel; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—33 to 60 inches; yellowish brown (10YR 5/4) and pale brown (10YR 6/3) gravelly coarse sand; single grained; loose; few white (10YR 8/2) nodules (calcium carbonate); about 30 percent gravel; strong effervescence; moderately alkaline.

The solum ranges from 7 to 20 inches in thickness. The mollic epipedon ranges from 7 to 14 inches in thickness. Carbonates commonly range from a depth of 0 to 20 inches.

The Bw horizon has value of 3 to 5 and chroma of 3 or 4. It typically is gravelly loamy sand, but in some pedons it is less than 15 percent gravel, by volume. The C horizon has value of 4 to 6 and chroma of 3 to 6. It is about 5 to 40 percent gravel, by volume.

Ida Series

The Ida series consists of well drained, moderately permeable, calcareous soils on ridgetops and side slopes in the uplands. These soils formed in loess. Native vegetation was prairie grasses. Slopes range from 5 to 40 percent.

Typical pedon of Ida silt loam, 14 to 20 percent slopes, severely eroded, in cropland; 2,500 feet north and 280 feet west of the southeast corner of sec. 27, T. 90 N., R. 41 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) and brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; mixed with some streaks and pockets of dark yellowish brown (10YR 4/4) underlying material; weak fine subangular blocky structure parting to weak fine granular; friable; few white (10YR 8/2) nodules (calcium carbonate); strong effervescence; mildly alkaline; clear smooth boundary.

C1—7 to 18 inches; dark yellowish brown (10YR 4/4) silt loam; massive; friable; few white (10YR 8/2) nodules and common soft white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C2—18 to 30 inches; yellowish brown (10YR 5/4) silt loam; massive; friable; few dark yellowish brown (10YR 4/4) channel fillings; few white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C3—30 to 60 inches; yellowish brown (10YR 5/4) silt loam; common fine faint grayish brown (10YR 5/2) mottles; massive; friable; common soft dark reddish brown (5YR 3/2) concretions (iron oxides); common soft white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum typically is less than 10 inches thick. It is the same as the A or Ap horizon.

The A horizon has value of 3 to 5 and chroma of 2 to 4. The C horizon has chroma of 3 to 6. It has few or common mottles and in some pedons is as shallow as 10 to 18 inches below the A horizon. Lime nodules typically are throughout the profile, but in some pedons they are not in the A or Ap horizon.

Judson Series

The Judson series consists of moderately well drained, moderately permeable soils on foot slopes and alluvial fans and in drainageways in the uplands. These soils formed in silty local alluvium derived from loess. Native vegetation was prairie grasses. Slopes range from 2 to 5 percent.

Typical pedon of Judson silty clay loam, 2 to 5 percent slopes, in cropland; 640 feet east and 1,700 feet south of the northwest corner of sec. 7, T. 91 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

A1—8 to 19 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak very fine granular; friable; medium acid; clear smooth boundary.

A2—19 to 25 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 4/3) dry; few discontinuous black (10YR 2/1) coatings on faces of peds; moderate fine and very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

BA—25 to 32 inches; brown (10YR 4/3) silty clay loam; few discontinuous very dark grayish brown (10YR

3/2) coatings on faces of peds; moderate fine and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw1—32 to 41 inches; brown (10YR 4/3) silty clay loam; moderate fine and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw2—41 to 48 inches; brown (10YR 4/3) silty clay loam; few medium distinct yellowish red (5YR 4/6) mottles; moderate medium and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—48 to 60 inches; brown (10YR 4/3) silty clay loam; few fine faint grayish brown (10YR 5/2) and few fine distinct yellowish red (5YR 4/6) mottles; massive; friable; slightly acid.

The solum ranges from 40 to more than 60 inches in thickness.

The A horizon typically ranges from 24 to 36 inches in thickness. It commonly is silty clay loam, but the range includes silt loam. The Bw and C horizons have value of 3 to 5 and chroma of 3 or 4. In some pedons value of 3 extends to a depth of 40 to 60 inches. The C horizon typically is silty clay loam, but the range includes silt loam.

Kennebec Series

The Kennebec series consists of moderately well drained, moderately permeable soils on low stream terraces. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Kennebec silty clay loam, 0 to 2 percent slopes, in pasture; 1,640 feet west and 1,900 feet south of the northeast corner of sec. 14, T. 92 N., R. 40 W.

A1—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate medium and fine granular; friable; neutral; clear smooth boundary.

A2—8 to 17 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure parting to weak fine granular; friable; neutral; gradual smooth boundary.

A3—17 to 25 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; continuous black (10YR 2/1) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A4—25 to 33 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (2.5Y 4/2) dry; discontinuous black(10YR 2/1) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

A5—33 to 42 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; moderate medium and fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

AC1—42 to 53 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; friable; neutral; diffuse smooth boundary.

AC2—53 to 60 inches; dark brown (10YR 3/3) silty clay loam, grayish brown (10YR 5/2) dry; continuous very dark grayish brown (10YR 3/2) coatings on faces of peds; few fine faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; neutral.

Solum thickness and thickness of the mollic epipedon typically are more than 36 inches. The content of fine or coarser sand typically is less than 10 percent above a depth of 40 inches.

The A and AC horizons typically are silty clay loam, but the range includes silt loam.

Marcus Series

The Marcus series consists of poorly drained, moderately slowly permeable soils on broad flats and drainageways in the uplands. These soils formed in loess. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Marcus silty clay loam, 0 to 2 percent slopes, in cropland; 1,860 feet west and 310 feet north of the southeast corner of sec. 9, T. 93 N., R. 42 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate medium and fine granular; friable; neutral; abrupt smooth boundary.

A—10 to 15 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few black (10YR 2/1) concretions (manganese oxides); slightly

acid; gradual smooth boundary.

AB—15 to 19 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; common fine distinct very dark grayish brown (2.5Y 3/2) and few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; few black (10YR 2/1) concretions (manganese oxides); neutral; clear smooth boundary.

Bg1—19 to 24 inches; olive gray (5Y 4/2) silty clay loam; common medium faint dark gray (5Y 4/1) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; some black (10YR 2/1) root channel fillings; few strong brown (7.5YR 5/8) and black (10YR 2/1) concretions (manganese oxides); neutral; gradual smooth boundary.

Bg2—24 to 31 inches; olive gray (5Y 4/2) silty clay loam; common medium faint dark gray (5Y 4/1) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and fine subangular blocky structure; friable; some black (10YR 2/1) root channel fillings; common strong brown (7.5YR 5/8) and black (10YR 2/1) concretions (iron and manganese oxides); mildly alkaline; gradual smooth boundary.

Bg3—31 to 40 inches; olive gray (5Y 5/2) silty clay loam; common medium faint gray (5Y 5/1) and common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium and fine subangular blocky structure; friable; common soft strong brown (7.5YR 5/8) and black (10YR 2/1) accumulations (iron and manganese oxides); mildly alkaline; gradual smooth boundary.

BCg—40 to 46 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; common soft strong brown (7.5YR 5/8) and black (10YR 2/1) accumulations (iron and manganese oxides); mildly alkaline; clear smooth boundary.

Cg—46 to 60 inches; olive gray (5Y 5/2) and light olive gray (5Y 6/2) silt loam; many medium distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8) mottles; massive; friable; common soft strong brown (7.5YR 5/8) and black (10YR 2/1) concretions (iron and manganese oxides); common soft white (10YR 8/2) accumulations and few white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. The depth to free carbonates ranges from 24 to 48 inches.

The A horizon has hue of N or 10YR and chroma of 0 or 1. It is silty clay loam or silty clay and is 36 to 42 percent clay. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 5Y or 2.5Y, value of 5 or 6, and chroma of 1 or 2.

Ocheyedan Series

The Ocheyedan series consists of well drained, moderately permeable soils on uplands and stream terraces. These soils formed in loamy and silty glacial sediments. Native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Ocheyedan loam, 2 to 5 percent slopes, in cropland; 1,400 feet east and 320 feet south of the northwest corner of sec. 15, T. 93 N., R. 39 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, brown (10YR 4/3) dry; moderate medium clods parting to weak fine granular structure; friable; medium acid; abrupt smooth boundary.

AB—8 to 11 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

Bw1—11 to 15 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) krotovinas in lower part of horizon; neutral; clear smooth boundary.

Bw2—15 to 25 inches; brown (10YR 4/3) sandy loam; weak medium and fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) krotovinas; neutral; gradual smooth boundary.

Bw3—25 to 35 inches; dark yellowish brown (10YR 4/4) sandy loam; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

2BC—35 to 46 inches; mottled yellowish brown (10YR 5/6) and grayish brown (2.5Y 5/2) silt loam; weak medium subangular blocky structure; friable; few yellowish red (5YR 4/6) and soft dark brown (7.5YR 3/2) concretions (iron and manganese oxides); neutral; abrupt smooth boundary.

2C1—46 to 53 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/8) silt loam; massive; friable; few yellowish red (5YR 4/6) and soft dark brown (7.5YR 3/2) concretions (iron and manganese oxides); common soft white (10YR 8/2)

accumulations (calcium carbonate); strong effervescence; moderately alkaline; clear smooth boundary.

2C2—53 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; few yellowish red (5YR 4/6) and soft dark brown (7.5YR 3/2) concretions (iron and manganese oxides); common soft white (10YR 8/2) accumulations and common white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 30 to 48 inches in thickness. The solum does not have coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon is loam, sandy clay loam, or sandy loam. The 2BC and 2C horizons are variable in texture, and range from silt loam and sandy loam to sandy clay loam. In a few pedons the 2C horizon contains lenses of loamy sand less than 6 inches thick that are interbedded with silt loam material. The 2C horizon commonly has hue of 10YR and 2.5Y, value of 4 to 6, and chroma of 2 to 6.

The Ocheyedan soil in map unit 878C2 is a taxadjunct to the Ocheyedan series because the dark colored surface soil is thinner than required for a mollic epipedon.

Omadi Series

The Omadi series consists of moderately well drained, moderately permeable soils on bottom land. These soils formed in silty alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Omadi silty clay loam, 0 to 2 percent slopes, in cropland; 1,760 feet north and 1,190 feet east of the southwest corner of sec. 16, T. 93 N., R. 39 W.

A—0 to 14 inches; very dark gray (10YR 3/1) silty clay loam (29 percent clay), dark gray (10YR 4/1) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak medium and fine granular structure; friable; few snail shells; slight effervescence; moderately alkaline; clear smooth boundary.

AC—14 to 22 inches; very dark gray (10YR 3/1) silty clay loam (29 percent clay), dark gray (10YR 4/1) dry; weak fine granular structure; friable; few thin dark grayish brown (10YR 4/2) strata; slight effervescence; moderately alkaline; gradual smooth boundary.

C1—22 to 33 inches; very dark gray (10YR 3/1) silt loam; appears massive, but has weak distinct bedding planes; friable; few thin dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) strata; few black (10YR 2/1) channel fillings; slight effervescence; moderately alkaline; clear smooth boundary.

C2—33 to 41 inches; dark grayish brown (10YR 4/2) and very dark gray (10YR 3/1) silt loam; appears massive, but has weak distinct bedding planes; friable; slight effervescence; moderately alkaline; abrupt smooth boundary.

C3—41 to 45 inches; stratified very dark gray (10YR 3/1), dark gray (10YR 4/1), and grayish brown (10YR 5/2) silt loam; appears massive, but has weak distinct bedding planes; friable; few soft strong brown (7.5YR 5/6) concretions (iron oxides); slight effervescence; moderately alkaline; abrupt smooth boundary.

C4—45 to 60 inches; very dark gray (10YR 3/1) and black (10YR 2/1) silty clay loam; appears massive, but has weak distinct bedding planes; friable; few soft strong brown (7.5YR 4/6) concretions (iron oxides); slight effervescence; mildly alkaline.

The solum ranges from 20 to 26 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It commonly is silty clay loam but ranges to silt loam. The C horizon dominantly has chroma of 1 or 2. The strata in this horizon have value of 4 to 6 and chroma of 1 or 2. The horizon commonly is silt loam but ranges to silty clay loam. The content of clay in the control section commonly ranges from 22 to 28 percent clay.

Primghar Series

The Primghar series consists of somewhat poorly drained, moderately permeable soils on linear to slightly convex ridges in the uplands and on concave side slopes and drainageways in the uplands. These soils formed in loess. Native vegetation was prairie grasses. Slopes range from 0 to 4 percent.

Typical pedon of Primghar silty clay loam, 0 to 2 percent slopes, in cropland; 880 feet south and 410 feet west of the northeast corner of sec. 7, T. 93 N., R. 42 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; medium acid; clear smooth boundary.

A—8 to 12 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine

subangular blocky structure; friable; neutral; gradual smooth boundary.

AB—12 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; some mixings of very dark grayish brown (2.5Y 3/2) subsoil material in lower part; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—17 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine faint olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) coatings in root channels and on faces of a few peds; few soft black (10YR 2/1) concretions (manganese oxides); neutral; gradual smooth boundary.

Bw2—25 to 36 inches; dark grayish brown (2.5Y 4/2) silty clay loam; few fine faint olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; common soft black (10YR 2/1) concretions (manganese oxides); mildly alkaline; gradual smooth boundary.

BC—36 to 49 inches; grayish brown (2.5Y 5/2) silt loam; many medium faint light olive brown (2.5Y 5/4) and common fine distinct strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; friable; common soft black (10YR 2/1) concretions (manganese oxides); common white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.

C—49 to 60 inches; mottled grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) silt loam; massive; friable; many soft black (10YR 2/1) concretions (manganese oxides); common soft white (10YR 8/2) accumulations and few white (10YR 8/2) nodules (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. The depth to carbonates ranges from 24 to 50 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The upper part of the Bw horizon has hue of 2.5Y or 10YR. The C horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 2 to 4. Mottles, which are few to many, have hue of 2.5Y or 7.5YR, value of 4 to 6, and chroma of 1 to 6.

Sac Series

The Sac series consists of well drained, moderately slowly permeable and moderately permeable soils on ridgetops and side slopes in the uplands. These soils formed in loess and the underlying loam or clay loam glacial till. Native vegetation was prairie grasses. Slopes range from 2 to 9 percent.

Typical pedon of Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes, in cropland; 888 feet south and 200 feet west of the northeast corner of sec. 5, T. 93 N., R. 41 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium clods parting to weak fine and medium granular structure; friable; slightly acid; clear smooth boundary.

A—8 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; moderate very fine and fine subangular blocky structure; friable; few fine black (10YR 2/1) channel fillings; slightly acid; clear smooth boundary.

BA—14 to 20 inches; dark brown (10YR 3/3) silty clay loam, yellowish brown (10YR 5/4) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate medium subangular blocky structure; friable; few fine black (10YR 2/1) channel fillings; neutral; clear smooth boundary.

Bw1—20 to 29 inches; brown (10YR 4/3) silty clay loam; discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bw2—29 to 35 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

2BC—35 to 40 inches; dark yellowish brown (10YR 4/4) clay loam; weak medium subangular blocky structure; firm; few soft black (10YR 2/1) concretions (manganese oxides); few white (10YR 8/2) accumulations (calcium carbonate); few pebbles 0.5-1 cm; strong effervescence; moderately alkaline; clear smooth boundary.

2C—40 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium faint yellowish brown (10YR 5/8) and common medium distinct gray (10YR 5/1) mottles; massive; firm; few soft black (10YR 2/1) concretions (manganese oxides); common soft white (10YR 8/2) accumulations and common white (10YR 8/2) nodules (calcium carbonate); few pebbles 0.5-1 cm; strong effervescence; moderately alkaline.

The solum ranges from 30 to 44 inches in thickness. Glacial till is at a depth of 24 to 40 inches.

The A horizon has chroma of 1 to 3. The Bw horizon has chroma of 3 or 4. The 2C horizon has chroma of 4 or 6 and mottles of high and low chroma. It is loam or clay loam.

The Sac soils in map units 77B2, 77C2, 78B2, and 78C2 are taxadjuncts to the Sac series because the dark colored surface soil is thinner than required for a mollic epipedon.

Sperry Series

The Sperry series consists of very poorly drained, slowly permeable soils in slight depressions and on stream terraces and uplands. These soils formed in loess. Native vegetation was prairie grasses. Slopes range from 0 to 1 percent.

These soils are taxadjuncts to the Sperry series because they do not have the abrupt textural change between the albic and argillic horizons that is definitive for the Sperry series.

Typical pedon of Sperry silty clay loam, 0 to 1 percent slopes, in corn; 530 feet east and 175 feet south of the northwest corner of sec. 7, T. 93 N., R. 40 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium clods parting to weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A—6 to 11 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; medium acid; abrupt smooth boundary.

E1—11 to 14 inches; grayish brown (10YR 5/2) and light brownish gray (10YR 6/2) silt loam; few fine faint strong brown (7.5YR 5/6) mottles; weak medium platy structure; friable; few black (10YR 2/1) channel fillings; few black (10YR 2/1) concretions (manganese oxides); medium acid; abrupt smooth boundary.

E2—14 to 18 inches; grayish brown (10YR 5/2) and light gray (10YR 7/2) silt loam; few fine faint strong brown (7.5YR 5/6) mottles; moderate medium platy structure; friable; few black (10YR 2/1) concretions (manganese oxides); slightly acid; abrupt smooth boundary.

Btg1—18 to 23 inches; dark gray (10YR 4/1) silty clay loam; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; few fine faint strong brown (7.5YR 5/6) mottles; moderate fine prismatic structure parting to weak thick platy parting to moderate fine angular blocky; friable; thin discontinuous clay films on faces of peds; many light gray (10YR 7/2) silt coatings on faces of peds; few black (10YR 2/1) concretions (manganese oxides); slightly acid; clear smooth boundary.

Btg2—23 to 29 inches; dark gray (10YR 4/1) silty clay loam; few fine prominent yellowish red (5YR 5/6 and 5/8) mottles; strong fine and medium prismatic structure; firm; thin discontinuous clay films on faces of peds; common light gray (10YR 7/2) silt coatings on faces of peds; few black (10YR 2/1) concretions (manganese oxides); slightly acid; clear smooth boundary.

Btg3—29 to 38 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent yellowish red (5YR 5/6 and 5/8) mottles; strong fine and medium prismatic structure; firm; thin discontinuous clay films on faces of peds; common light gray (10YR 7/2) silt coatings on faces of peds; few black (10YR 2/1) concretions (manganese oxides); slightly acid; gradual smooth boundary.

BCg—38 to 50 inches; dark grayish brown (2.5Y 4/2) and grayish brown (10YR 5/2) silty clay loam; few prominent yellowish red (5YR 5/6) mottles; strong medium prismatic structure; friable; few light gray (10YR 7/2) silt coatings on faces of peds; common black (10YR 2/1) channel fillings; few black (10YR 2/1) concretions (manganese oxides); slightly acid; diffuse smooth boundary.

Cg—50 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; few distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; few black (10YR 2/1) channel fillings; few black (10YR 2/1) concretions (manganese oxides); neutral.

The solum ranges from 45 to 60 inches in thickness. The mollic epipedon ranges from 10 to 15 inches in thickness.

The A horizon has value of 2 or 3. It typically is silty clay loam but ranges to silt loam. The E horizon has value of 4 to 7 and chroma of 1 or 2. The Btg horizon has hue of 10YR to 5Y and value of 3 to 5. The BCg and Cg horizons have hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 or 2.

Spillco Series

The Spillco series consists of moderately well drained, moderately permeable soils on bottom land and along intermittent streams. These soils formed in calcareous loamy alluvium. Native vegetation was

prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Spillco loam, channeled, 0 to 2 percent slopes, in pasture; 180 feet west and 940 feet south of the northeast corner of sec. 23, T. 93 N., R. 41 W.

A1—0 to 9 inches; black (10YR 2/1) and very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; few very fine snail shells; mildly alkaline; clear smooth boundary.

A2—9 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few black (10YR 2/1) channel fillings; mildly alkaline; abrupt smooth boundary.

A3—14 to 43 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; few black (10YR 2/1) channel fillings; slight effervescence; moderately alkaline; gradual smooth boundary.

C—43 to 60 inches; very dark gray (10YR 3/1) sandy loam; discontinuous black (10YR 2/1) coatings on faces of peds; massive; friable; few pebbles 0.5-2 cm; slight effervescence; moderately alkaline.

The solum ranges from 36 to 50 inches in thickness. Depth to carbonates typically is 14 to 30 inches.

The A horizon has chroma of 1 or 2 in the upper part and value of 2 or 3 and chroma of 1 or 2 in the lower part. The A horizon commonly is loam but includes silt loam containing noticeable sand. The C horizon is loam, sandy loam, or clay loam.

Spillville Series

The Spillville series consists of moderately well drained, moderately permeable soils on bottom land, alluvial fans, and foot slopes along narrow drainageways in the uplands. These soils formed in loamy alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Spillville loam, 0 to 2 percent slopes, in cropland; 700 feet north and 1,120 feet west of the southeast corner of sec. 3, T. 93 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; cloddy; friable; neutral; clear smooth boundary.

A1—8 to 20 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A2—20 to 34 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark gray (10YR 3/1) coatings on faces of peds; weak medium subangular blocky structure; friable; slightly acid; diffuse smooth boundary.

A3—34 to 48 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium and fine subangular blocky structure; friable; neutral; gradual smooth boundary.

C—48 to 60 inches; dark brown (10YR 3/3) loam; few fine faint dark yellowish brown (10YR 4/4) mottles; massive; friable; neutral.

The solum ranges from 40 to 56 inches in thickness.

The A horizon is commonly loam but includes silt loam containing noticeable sand. The C horizon has value of 3 or 4 and chroma of 1 to 3.

Steinauer Series

The Steinauer series consists of well drained, moderately slowly permeable soils on upland side slopes. These soils formed in firm, clay loam glacial till. Native vegetation was prairie grasses. Slopes range from 9 to 40 percent.

Typical pedon of Steinauer clay loam, 25 to 40 percent slopes, in pasture; 1,120 feet north and 440 feet east of the southwest corner of sec. 23, T. 93 N., R. 41 W.

A—0 to 5 inches; very dark gray (10YR 3/1) clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; about 5 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

AC—5 to 11 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) and dark grayish brown (10YR 4/2) dry; some mixings of dark gray (10YR 4/1) material; weak medium and fine subangular blocky structure; firm; about 5 percent gravel; strong effervescence; moderately alkaline; clear smooth boundary.

C1—11 to 37 inches; yellowish brown (10YR 5/4) clay loam; common fine faint yellowish brown (10YR 5/6) and common fine distinct gray (10YR 6/1) mottles; massive with medium angular planes of cleavage; firm; few soft black (10YR 2/1) concretions (manganese oxides); few white (10YR 8/2) nodules (calcium carbonate); about 5 percent gravel; violent effervescence; moderately alkaline; diffuse smooth boundary.

C2—37 to 60 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct light brownish gray (10YR 6/2) and gray (10YR 6/1) and few fine faint yellowish brown (10YR 5/6) mottles; massive with strong angular planes of cleavage; firm; few black (10YR 2/1) concretions (manganese oxides); common soft white (10YR 8/2) accumulations and common white (10YR 8/2) nodules (calcium carbonate); about 5 percent gravel; violent effervescence; moderately alkaline.

The solum ranges from 4 to 20 inches in thickness. Depth to carbonates ranges from the surface to about 14 inches.

The A horizon has value of 3 to 5 and chroma of 1 or 2. It typically is clay loam, but the range includes loam. The AC horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 1 to 4. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Steinauer Variant

The Steinauer Variant consists of poorly drained, very slowly permeable soils on upland side slopes. These soils formed in clayey lacustrine sediments. Native vegetation was prairie grasses. Slopes range from 20 to 50 percent.

Typical pedon of Steinauer Variant clay loam, in an area of Steinauer-Steinauer Variant clay loams, 20 to 50 percent slopes, in pasture; 2,030 feet north and 1,200 feet west of the southeast corner of sec. 22, T. 91 N., R. 40 W.

A1—0 to 7 inches; black (10YR 2/1) and very dark brown (10YR 2/2) clay loam (37 percent clay), very dark gray (10YR 3/1) dry; weak fine and very fine granular structure; friable; neutral; clear smooth boundary.

A2—7 to 12 inches; very dark grayish brown (10YR 3/2) clay loam (39 percent clay), dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; few fine faint dark yellowish brown (10YR 4/6) mottles; weak fine and very fine granular structure; friable; common black (10YR 2/1) channel fillings; neutral; abrupt smooth boundary.

AB—12 to 16 inches; very dark grayish brown (10YR 3/2) clay (42 percent clay), dark grayish brown (10YR 4/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; few fine faint dark yellowish brown (10YR 4/6) and yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; common black (10YR 2/1) channel fillings; slight effervescence; mildly alkaline; clear smooth boundary.

2Btg1—16 to 20 inches; grayish brown (10YR 5/2) silty clay (50 percent clay); few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine and very fine subangular blocky structure; very firm; few black (10YR 2/1) channel fillings; slight effervescence; mildly alkaline; clear smooth boundary.

2Btg2—20 to 47 inches; light brownish gray (2.5Y 6/2) silty clay (55 percent clay); few fine distinct dark yellowish brown (10YR 4/6) and gray (5Y 5/1) mottles in lower part; moderate fine and very fine subangular blocky structure; very firm; few fine faint grayish brown (2.5Y 5/2) clay skins; few soft white (N 8/0) accumulations and few white (N 8/0) nodules (calcium carbonate); slight effervescence; mildly alkaline; gradual smooth boundary.

2Btg3—47 to 60 inches; grayish brown (2.5Y 5/2), very dark gray (10YR 3/1), and dark gray (10YR 4/1) clay (62 percent clay); few fine distinct yellowish brown (10YR 5/8) mottles; moderate fine and very fine subangular blocky structure; very firm; slight effervescence; mildly alkaline.

The solum ranges from 30 to 60 inches or more in thickness. Depth to carbonates ranges from 10 to 20 inches.

The A horizon typically is clay loam, but the range includes clay. The 2Btg horizon has chroma of 1 or 2.

Storden Series

The Storden series consists of well drained, moderately permeable soils on upland side slopes. These soils formed in glacial till. Native vegetation was prairie grasses. Slopes range from 9 to 50 percent.

Typical pedon of Storden loam, 25 to 50 percent slopes, in pasture; 2,460 feet east and 340 feet south of the northwest corner of sec. 21, T. 93 N., R. 39 W.

A1—0 to 4 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

A2—4 to 9 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of

peds; weak fine subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

AC—9 to 15 inches; brown (10YR 4/3) and yellowish brown (10YR 5/4) loam, very pale brown (10YR 7/4) dry; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

C—15 to 60 inches; yellowish brown (10YR 5/4) loam; few medium distinct strong brown (7.5YR 5/8) mottles; massive; friable; few dark reddish brown (2.5YR 3/4) concretions (iron oxides); common soft white (10YR 8/2) accumulations and common white (10YR 8/2) nodules (calcium carbonate); few shale fragments 0.2 to 0.8 cm; violent effervescence; moderately alkaline.

The solum ranges from 7 to 18 inches in thickness. Free carbonates commonly are in all horizons.

The A horizon has value of 3 to 5 and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 6.

Terril Series

The Terril series consists of moderately well drained, moderately permeable soils on slightly concave foot slopes, alluvial fans, and stream terraces. These soils formed in loamy local alluvium derived from glacial till. Native vegetation was prairie grasses. Slopes range from 0 to 9 percent.

Typical pedon of Terril loam, 5 to 9 percent slopes; 2,060 feet north and 2,160 feet east of the southwest corner of sec. 2, T. 93 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine and very fine granular; friable; slightly acid; clear smooth boundary.

A1—8 to 13 inches; black (10YR 2/1) loam, very dark grayish (10YR 3/1) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A2—13 to 23 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; discontinuous black (10YR 2/1) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few black (10YR 2/1) channel fillings; neutral; clear smooth boundary.

A3—23 to 32 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; discontinuous very dark brown (10YR 2/2) coatings on faces of peds; weak medium subangular blocky structure; friable; few black (10YR 2/1) channel fillings; neutral; gradual smooth boundary.

BA—32 to 40 inches; dark brown (10YR 3/3) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium subangular blocky structure; friable; few very dark brown (10YR 2/2) channel fillings; neutral; gradual smooth boundary.

Bw1—40 to 47 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) loam; discontinuous dark brown (10YR 3/3) coatings on faces of peds; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—47 to 53 inches; brown (10YR 4/3) and dark yellowish brown (10YR 4/4) clay loam; weak coarse and medium subangular blocky structure; friable; mildly alkaline; abrupt smooth boundary.

C—53 to 60 inches; dark yellowish brown (10YR 4/4) loam; massive; friable; strong effervescence; moderately alkaline.

The solum ranges from 40 inches to more than 60 inches in thickness.

The A horizon ranges from 24 to 36 inches in thickness. The A horizon generally is loam, but in some pedons it is silt loam high in sand and clay content. The Bw and C horizons commonly are loam and clay loam, but the range includes sandy clay loam and sandy loam.

Turlin Series

The Turlin series consists of somewhat poorly drained, moderately permeable soils on stream terraces, foot slopes, and alluvial fans. These soils formed in loamy alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Turlin loam, 0 to 2 percent slopes, in cropland; 1,730 feet west and 1,530 feet north from the southeast corner of sec. 8, T. 93 N., R. 39 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

A1—8 to 14 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine granular structure; friable; neutral; gradual smooth boundary.

A2—14 to 22 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few pebbles 0.5 to 1.0 cm; neutral; gradual smooth boundary.
A3—22 to 29 inches; black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; very dark gray (10YR 3/1) krotovinas in lower 2 inches of horizon; few pebbles 0.5 to 1.0 cm; mildly alkaline; gradual smooth boundary.
AB—29 to 33 inches; very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; mildly alkaline; gradual smooth boundary.
Bw1—33 to 42 inches; dark grayish brown (10YR 4/2) loam; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium and fine subangular blocky structure; friable; few very dark gray (10YR 3/1) channel fillings; very few soft white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline; gradual smooth boundary.
Bw2—42 to 60 inches; dark grayish brown (10YR 4/2) loam; discontinuous very dark grayish brown (10YR 3/2) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; few soft white (10YR 8/2) accumulations (calcium carbonate); strong effervescence; moderately alkaline.

The solum ranges from 33 to 60 inches or more in thickness. It typically is loam and less commonly is clay loam. The mollic epipedon ranges from 24 to 36 inches thick. Depth to carbonates typically is 27 to 40 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has value of 4 or 5 and chroma of 2 but with depth ranges to chroma of 3 and has mottles that have chroma of 2 to 6.

Wadena Series

The Wadena series consists of well drained soils on stream terraces. These soils formed in loamy material over sand and gravel. Permeability is moderate over very rapid. Native vegetation was prairie grasses. Slopes range from 0 to 5 percent.

Typical pedon of Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes, in cropland; 1,430 feet east and 1,334 feet north of the southwest corner of sec. 29, T. 91 N., R. 40 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) and black (10YR 2/1) loam, dark grayish brown (10YR 4/2) dry; moderate medium clods parting to weak fine granular structure; friable; slightly acid; clear smooth boundary.
A—6 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; continuous very dark brown (10YR 2/2) coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; friable; few brown (10YR 4/3) krotovinas; neutral; gradual smooth boundary.
BA—12 to 17 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine and very fine subangular blocky structure; friable; common very dark brown (10YR 2/2) worm channel casts; neutral; gradual smooth boundary.
Bw—17 to 27 inches; dark yellowish brown (10YR 4/4) loam; weak medium and fine subangular blocky structure; friable; neutral; abrupt smooth boundary.
2C1—27 to 29 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) gravelly sand; single grained; loose; neutral; abrupt smooth boundary.
2C2—29 to 60 inches; brown (10YR 5/3) gravelly sand; single grained; loose; strong effervescence; moderately alkaline.

Solum thickness and depth to the 2C horizon range from 24 to 32 inches. The mollic epipedon is 10 to 17 inches thick.

The A horizon has chroma of 1 or 2. The Bw horizon has value of 3 to 5 and chroma of 3 or 4. The 2C horizon has value of 4 to 6 and chroma of 2 to 4. It commonly is gravelly sand or very gravelly coarse sand but ranges to coarse sand or sand.

Zook Series

The Zook series consists of poorly drained, slowly permeable soils on bottom land. These soils formed in silty and clayey alluvium. Native vegetation was prairie grasses. Slopes range from 0 to 2 percent.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, in cropland; 1,810 feet east and 1,440 feet north of the southwest corner of sec. 21, T. 90 N., R. 39 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam; very dark gray (10YR 3/1) dry; moderate fine angular blocky structure parting to weak fine granular; friable; neutral; abrupt smooth boundary.
A1—8 to 17 inches; black (N 2/0) silty clay loam, very

dark gray (N 3/0) dry; moderate very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A2—17 to 25 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine and very fine subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—25 to 33 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine prismatic structure parting to moderate fine and very fine subangular blocky; friable; neutral; gradual smooth boundary.

Bg1—33 to 44 inches; very dark gray (5Y 3/1) silty clay loam; continuous black (5Y 2/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to moderate medium and fine subangular blocky; firm; thin discontinuous clay films on faces of peds; few black (10YR 2/1) concretions (manganese oxides); neutral; clear smooth boundary.

Bg2—44 to 53 inches; very dark gray (5Y 3/1) silty clay loam; continuous black (5Y 2/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium and fine subangular blocky; firm; thin discontinuous clay films on faces of peds; few black (10YR 2/1) concretions (manganese oxides); neutral; diffuse smooth boundary.

BCg—53 to 60 inches; dark gray (5Y 4/1) silty clay loam; discontinuous black (5Y 2/1) coatings on faces of peds; few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; few black (10YR 2/1) concretions (manganese oxides); neutral.

The solum ranges from 36 to 60 inches or more in thickness. The mollic epipedon ranges from 36 to 55 inches in thickness. The clay content in the solum ranges from 33 to 42 percent.

The A horizon ranges from 27 to 40 inches in thickness. Value of 3 or less extends to a depth of more than 36 inches. The Bg horizon has hue of 10YR, 2.5Y, or 5Y and value of 3 or 4.

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Formation of the Soils

In this section the major factors of soil formation are described and related to the soils of Cherokee County. Also described are the processes that result in the formation of soil horizons.

Factors of Soil Formation

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical properties of and the chemical and mineralogical composition of the parent material. Also, they are determined by the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief; and the length of time that the forces of soil formation have acted on the soil material *(10)*. Human activities also affect soil formation.

Climate and plant and animal life are the active factors of soil formation. They act on the unconsolidated mineral parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of profile that forms and the rate at which it forms. In extreme cases it almost entirely determines profile formation. Finally, time is required for the changing of parent material into a soil. The amount of time required is determined by the rate of the soil-forming processes. A long period of time generally is needed for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others.

Parent Material

The soils of Cherokee County formed in loess, glacial drift, alluvium, and sediments deposited by wind and water. These materials were transported from areas where they had weathered from rocks and were deposited at new locations in the county through the action of glacial ice, water, wind, and gravity.

Loess, a silty material deposited by wind, is the most extensive parent material in the county. Soils formed partly or entirely in loess make up about 81 percent of Cherokee County. The loess ranges in depth from about 2 to 11 feet. It overlies glacial till and to a lesser extent stratified sand and gravel. The base of the Wisconsinan loess in Iowa is 16,500 to 29,000 years old *(15)*. The loess is thickest in the southwestern part of the county, and is thinnest in the northeastern part.

The loess consists mostly of silt and some clay. It generally does not contain coarse sand, gravel, or cobbles except near the boundary of the loess and the underlying glacial drift. The content of fine sand and very fine sand generally is less than 5 percent. Concretions and accumulations of lime generally are at depths of 2½ to 4 feet, although lime accumulations commonly occur throughout the profile of the Ida soils in the southern part of the county.

Galva, Primghar, Marcus, and Ida soils formed in a layer of loess more than 40 inches thick. Sac soils formed in a layer of loess less than 40 inches deep over glacial till. On steep side slopes adjacent to the Mill Creek Valley and the Little Sioux River Valley, the loess has been removed by geologic erosion, and glacial till is exposed. On some of the high stream terraces adjacent to these steep side slopes, the covering of loess deposits is 5 to 6½ feet thick in the northern part of the county, and is as thick as 10½ feet in the southern part of the county where they occupy lower positions on the landscape. Galva soils formed in this loess.

Glacial drift is all rock material transported or deposited by glacial ice and all material dominantly of glacial origin deposited in bodies of glacial meltwater. The glacial drift in Cherokee County is of two main kinds: glacial till and glacial outwash. Glacial till is unsorted sediment whose particles range in size from boulders to clay. Glacial outwash is stratified and sorted deposits of gravel, sand, and silt transported and

deposited by glacial meltwater.

The first two glaciations to occur in what is now Cherokee County were the Nebraskan and Kansan, which left drift deposits over the entire county. These two glacial periods, respectively, produced the oldest recognized deposits of the early Pleistocene Epoch. In the classical investigations of early Pleistocene glacial deposits, the beginning of the Pleistocene was estimated at about 1,000,000 years ago *(11)*. However, in recent years through advanced technology, such as the use of new drilling techniques and the development of radiometric age dating, the data shows that the sequence of Pleistocene glacial deposits is much more complex than previously recognized.

Evidence based on the fission-track method of dating volcanic ash deposits has revealed as many as four distinct till deposits below the classic Nebraskan till. Volcanic ash dated at about 2.2 million years old occurs at the top of the oldest recognized glacial deposit. This ash places the beginning of glaciation in Iowa at more than 2.2 million years ago. Also, paleosols are on the gently sloping to strongly sloping side slope positions. They are indicated on the soil maps by a spot symbol. They are at three distinct elevations, 1,420, 1,360, and 1,320 feet, throughout the county.

These paleosols, which are highly weathered, gray, very slowly permeable soils, are locally referred to as gumbotil. They are exposed weathered surfaces of an interglacial period, and may be an aid in understanding the stratigraphy of the Pleistocene deposits. Until more data is available, these older Pleistocene deposits may be referred to as pre-Illinoian glacial drift *(14, 5)*. In Cherokee County, the most recent period of glacial activity is the Tazewell Substage of the Wisconsinan Glaciation, which deposited drift in the northeastern part of the county. The margin of glaciation during the Tazewell Substage is along Mill Creek as it enters the north-central part of the county, south to Cherokee, and northeastward to the Maple River, where it leaves the county.

The most notable soil features of the glacial till in the Tazewell drift area are the loam texture, friable consistency, and presence of shale fragments. The most notable surface features of the Tazewell drift area are the thinner loess deposits over the glacial till on stable divides and the multilevel sand and gravel outwash terraces along the valleys of Mill Creek and Little Sioux River, Maple River, and their major tributaries. Radiocarbon tests of wood were obtained at the base of the glacial till near Cherokee and at other locations. The tests indicate that the Tazewell glacier deposited materials in Cherokee County about 22,000 to 14,000 years ago *(15)*. The loess-covered glacial till landscape in the northwestern part of Iowa appears to be a multilevel sequence of erosion surfaces, and many levels are cut into the underlying glacial till.

Glacial outwash of the Tazewell Substage is the parent material of most soils formed on stream terraces. The glacial outwash in the county consists typically of stratified sand and gravel and a variable content of silt, cobbles, stones, and boulders. Many terrace levels are in the Little Sioux River Valley and its major tributaries. These formed when the Cary Substage of the Wisconsinan Glaciation blocked streams flowing to the Mississippi River drainage system and diverted them toward the Missouri River drainage system. This blockage doubled the size of the original Little Sioux River drainage basin. This resulted in increased runoff and water flow through the Little Sioux River system, and initiated a period of cutting and filling, which resulted in the development of numerous present-day terrace levels. The degradation and modification of terraces occurred about 14,000 to 10,000 years ago *(6, 9)*.

In Cherokee County, the glacial till typically is loam and clay loam. Storden and Steinauer soils formed entirely in glacial till. Everly soils formed in about 1½ to 3 feet of loamy sediment and the underlying glacial till. Glacial outwash is the parent material of Allendorf, Estherville, Hawick, and Wadena soils. These soils are above the flood plain, and generally are not subject to flooding. In these soils, alluvium in the uppermost 12 to 42 inches is sandy loam, loam, silt loam, or silty clay loam, which is underlain by stratified silt, sand, and gravel.

Alluvium is material deposited by water along streams and rivers and in upland drainageways. Soils formed in alluvium make up about 15 percent of the county. The major areas where the soils formed in alluvium are along the Little Sioux River, Maple River, Mill Creek, and their major tributaries. Soils on flood plains, foot slopes, alluvial fans, stream terraces, and some upland drainageways formed in alluvium. As streams and rivers overflow their channels and water spreads over the flood plains, alluvial materials are deposited.

Much of the alluvium in Cherokee County washed from loess-covered slopes in the uplands. These alluvial sediments commonly are silty clay loam and silt loam. Colo, Omadi, and Zook soils formed in silty alluvium on bottom lands and are subject to flooding. Coland, Spillville, and Spillco soils, also on bottom land, are subject to flooding. These soils formed in clay loam and loam alluvium derived from material washed from

upland soils formed predominantly in glacial drift.

Some alluvial material has been transported only a short distance. This material is called local alluvium or colluvium, and retains many characteristics of the soils on slopes from which it eroded. Terril and Turlin soils formed in loamy local alluvium on foot slopes and alluvial fans directly below glacial deposits on steep side slopes. Judson soils formed in silty local alluvium on foot slopes and alluvial fans directly below loess-covered side slopes.

The origin and age of alluvial materials in Cherokee County and throughout the western Iowa loess region have been the subject of many studies. These studies stemmed from a renewed interest in the study of landscape changes to identify and protect archeological resources. The effects of erosion and alluviation during late Wisconsinan and Holocene Epochs have spanned about the last 12,000 years. The DeForest formation, comprising six stratigraphic members, is the foundation for understanding Holocene landscape evolution. The age of the Holocene alluvium was determined by radiocarbon dating, fossil association of plant and animal remains, and archeological deposits *(19)*.

Eolian sands are a very minor parent material in Cherokee County. Dickman sandy loam is the only soil formed in loamy and sandy glaciofluvial sediments reworked by wind. These sediments were deposited along the southern and eastern sides of the Little Sioux River, Mill Creek, and other major streams in the county. These deposits are associated and in places intermingled with loess, although they are much higher in content of sand than the deposits of loess.

Bedrock of the Cretaceous Period underlies the glacial drift deposits in Cherokee County, according to the Iowa Geological Survey. The well logs of deep core borings indicate the upper layers of bedrock are shale and sandstone. About 4 miles north of Cherokee, a deep well boring indicated 325 feet of Pleistocene glacial drift overlying Cretaceous bedrock, although depths to the bedrock range from 150 to 525 feet throughout northwest Iowa.

Climate

Climate has a major influence on soil formation. Soils form more rapidly in a warm climate than in a cold climate and more rapidly in a wet climate than in a dry climate. Except for small differences because of topography, the soils in Cherokee County formed in about the same climate. The climate has not, however, been the same during the entire period of soil formation.

The present upland soils in Cherokee County and in the northwestern part of Iowa in general began forming about 14,000 years ago. About this time loess deposition ended, the climate began a warming trend, and glacial conditions in Iowa began to recede *(15, 16)*. Temperatures warmed until about 7,500 years ago and then stabilized. At this time the moisture began to dwindle, and the climate became drier. From about 4,500 years ago to the present the climate became more humid *(9, 4)*. Climate is a direct influence on the soil because of the local temperature and moisture conditions, and also is an indirect influence because of its effect on the local vegetation.

Vegetation and Animal Life

Living organisms are important in soil formation. The activities of burrowing animals, for example, worms, crayfish, and micro-organisms, are reflected in soil properties. Vegetation, however, generally causes the most marked differences in soils. Grass, for example, has a dense system of roots in the surface layer. Relatively often, grass roots die and are replaced. The dead roots add organic matter to the soil. Soils that formed under grass typically have a thicker, darker colored surface layer than soils formed under trees; also, they are less acid and generally have a thinner, less developed subsoil than soils formed under trees.

The soils in Cherokee County formed mainly under prairie grasses but, in the past, other types of vegetation have grown on them. From about 14,000 to about 10,500 years ago, the vegetation changed from conifer dominant to conifer and deciduous transition. By about 8,500 years ago, a climax deciduous forest was in place. As the climate became drier, the forest vegetation was replaced by prairie grasses *(9)*. At about 5,000 years ago, a climax upland prairie was firmly in place and remained so up to present times *(4, 22)*.

The effect of trees on the soils occurred along the steep and very steep valley walls of rivers and creeks in the county, mostly on the north- and east-facing side slopes. On some soils on uplands adjacent to the Little Sioux River Valley, like Galva soils, maximum clay content is in the middle layer of the subsoil. This may indicate that trees were present on these soils for a period of time during their development. These soils are not extensive in the county.

The large burrowing animals, such as badgers, fox, and pocket gophers, have the most obvious influence on soil development. They drastically affect soil development in small areas. Small animals, such as earthworms and, in places, ants, have a widespread

influence on soil development. Earthworms move up and down in the soil with moisture changes in the soil. In most soil profiles examined in the county, earthworms had moved material from one soil horizon to another.

Relief

Relief, or topography, refers to the lay of the land. It ranges from level to very steep in Cherokee County. Relief is an important factor in soil formation because it affects drainage, runoff, height of the water table, and erosion. Soils formed in the same kind of parent material have different properties, mainly because of differences in relief.

The influence of relief in Cherokee County is evident in the soils formed in loess. These soils differ in color, thickness of the solum, and degree of development of horizons. Galva soils are in convex areas. They are nearly level to strongly sloping, and are well drained. Excess water runs off these soils; runoff or subsurface seepage does not collect on the surface. Primghar soils are on plane and concave areas. They are nearly level and gently sloping, and somewhat poorly drained. Marcus soils are in concave areas. They are nearly level and poorly drained. Primghar and Marcus soils generally receive runoff from adjacent soils, but runoff on these soils is minimal because they are nearly level or gently sloping. Primghar and Marcus soils have a seasonal high water table because of their position and because the glacial till under the loess slows the downward percolation of water. In most places Galva soils do not have a water table within 6 feet of the surface. If the water table rises above the glacial till, it is there only for a short period of time. Erosion is not a hazard on nearly level Primghar and Marcus soils, but in most areas Galva soils are subject to erosion.

Soil formation, according to the model developed by Runge *(17)*, is progressively slower in Marcus, Primghar, and Galva soils, in that order. Marcus soils have the most water available for plant growth and for the production of organic matter. They are moist enough for clay to form over the longest intervals each year. Marcus soils have the most organic matter and clay in the upper horizons and Galva soils have the least.

Relief also influences the color of the B horizon through its effect on surface and subsurface drainage. In the well drained Galva soils, the subsoil is brown because oxidized iron compounds are scattered throughout the soil profile. In the poorly drained Marcus soils, the subsoil is grayish or olive because of deoxidized, or reduced, iron compounds.

Relief, through its effect on the thickness of loess, also influences the distribution of soils *(13)*. Generally, the loess is less thick on convex ridgetops and side slopes than it is on plane to concave positions on the landscape. In some parts of the county Sac soils are associated with Galva and Primghar soils. Sac soils generally are on convex ridgetops and side slopes, and Galva and Primghar soils generally are on plane to concave side slopes and in drainageways.

Time

The soil undergoes constant change, but the change is so slow that it does not seem to take place. Microorganisms, chemical reactions, and movement of particles are what changes the soil from one moment to the next.

Time dictates the effects of climate, vegetation and animal life, and relief on parent material. It is how long each of these factors are able to act on the soil that results in the degree of soil development.

Radiocarbon dating has been used to determine the age of wood, bones, and other organic carbon materials in an alluvial fan deposit in Cherokee County *(9)*. The data from this site gives evidence of several periods of erosion from about 10,000 years ago to about 2,500 years ago. The erosion periods removed material from sloping areas and deposited sediments on the fan. The last increments of erosional sediments were deposited about 2,500 years ago; therefore, the soils formed on that surface must be younger *(8)*. In Cherokee County Terril and Judson soils are on these alluvial fan positions. These soils are among the youngest in the county.

Processes of Soil Formation

Horizon differentiation, or soil formation, is the result of four basic processes: additions, removals, transfers, and transformations *(18)*. The rate at which each of these processes occurs determines how rapidly a soil develops and the ultimate characteristics of the soil profile. These processes affect organic matter, soluble salts, carbonates, sesquioxides, and silicate clay minerals.

The accumulation of organic matter in the upper part of the soil profile helps in forming an A horizon and is an early phase in the formation of most soils. Generally, the soils that have a high content of organic matter also have a thick, dark surface layer. In the soils of Cherokee County, the content of organic matter in the A horizon ranges from high to very low. It is very low in the thin A horizon of Ida soils and high in the thick A

horizon of Colo soils. In some soils it is low or moderately low because erosion has removed part of the A horizon.

In most soils in the county, the removal of substances from parts of the soil profile is important in the differentiation of horizons. The downward movement of calcium carbonates and bases is an example. Percolating water removes bases and carbonates from the upper horizons and moves, or leaches, them downward in the soil profile. As this process occurs, structural development of the subsoil progresses, as in Galva and Sac soils. Other soils, however, have not been leached of carbonates and do not exhibit subsoil development; these soils are Ida, Omadi, Spillco, Steinauer, and Storden soils.

Phosphorus and other substances are transferred from one horizon to another in the soils of the county. Phosphorus, where available, is removed from the the subsoil by plant roots and transferred to the parts of the plant growing above the ground. It is then added to the surface layer in the plant residue. Transfer thus affects the form and distribution of phosphorus in the soil profile.

The translocation of silicate clay minerals is another important process in horizon development. Percolating water from the A horizon carries the clay minerals downward in suspension. The clay minerals accumulate in the B horizon as coatings or fillings in pores and root channels and as clay films on the faces of peds. Translocation has affected many of the soils in the county. In other soils, the clay content of the B horizon is not markedly different from that of the A horizon, and other evidence of clay movement is minimal.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basil till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle, the slippage of saturated soil, or both.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water

from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent,

by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay

particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Paleosol. A buried soil or formerly buried soil, especially one that formed during an interglacial period and was subsequently covered by glacial deposits.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability,

the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are—

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E,

and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Valley train. A long narrow body of glacial outwash confined within a valley below a glacier; it may, or may not, emerge from the valley and join an outwash plain.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and

bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-84 at Cherokee, Iowa)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	^oF	^oF	^oF	^oF	^oF	Units	In	In	In		In
January-----	25.6	3.8	14.7	52	-26	0	0.50	0.15	0.77	2	4.9
February----	32.1	10.2	21.2	58	-24	0	.85	.25	1.33	2	7.4
March-------	41.7	21.5	31.6	74	-8	18	1.64	.70	2.43	4	8.0
April-------	59.6	35.3	47.5	87	14	80	2.33	1.14	3.34	6	1.3
May---------	72.0	46.4	59.2	91	25	302	3.95	2.35	5.37	8	.0
June--------	81.1	56.5	68.8	97	38	564	4.68	2.08	6.90	7	.0
July--------	85.7	61.3	73.5	98	44	729	3.71	1.81	5.35	6	.0
August------	83.8	59.0	71.4	98	41	663	3.71	1.47	5.59	6	.0
September---	75.0	48.3	61.7	94	28	351	2.93	1.05	4.48	6	.0
October-----	63.8	37.1	50.5	88	17	133	2.04	.58	3.23	4	.1
November----	46.1	24.1	35.1	73	-1	0	1.26	.21	2.06	3	2.8
December----	31.5	11.3	21.4	58	-21	0	.77	.31	1.15	2	7.2
Yearly:											
Average----	58.2	34.6	46.4	---	---	---	---	---	---	---	---
Extreme----	---	---	---	100	-28	---	---	---	---	---	---
Total------	---	---	---	---	---	2,840	28.37	21.44	34.85	56	31.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-84 at Cherokee, Iowa)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 29	May 14	May 21
2 years in 10 later than--	Apr. 24	May 9	May 16
5 years in 10 later than--	Apr. 15	Apr. 28	May 7
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 4	Sept. 24	Sept. 15
2 years in 10 earlier than--	Oct. 9	Sept. 28	Sept. 20
5 years in 10 earlier than--	Oct. 20	Oct. 7	Sept. 30

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-84 at Cherokee, Iowa)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	164	144	129
8 years in 10	172	150	134
5 years in 10	187	161	145
2 years in 10	203	173	155
1 year in 10	211	179	160

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded	305	0.1
1D3	Ida silt loam, 9 to 14 percent slopes, severely eroded	530	0.1
1E3	Ida silt loam, 14 to 20 percent slopes, severely eroded	335	0.1
1G	Ida silt loam, 20 to 40 percent slopes	180	*
8B	Judson silty clay loam, 2 to 5 percent slopes	355	0.1
11B	Colo-Judson silty clay loams, 0 to 5 percent slopes	18,695	5.1
26	Kennebec silty clay loam, 0 to 2 percent slopes	645	0.2
27	Terril loam, 0 to 2 percent slopes	635	0.2
27B	Terril loam, 2 to 5 percent slopes	1,240	0.3
27C	Terril loam, 5 to 9 percent slopes	1,715	0.5
28B	Dickman sandy loam, 2 to 5 percent slopes	680	0.2
28D	Dickman sandy loam, 5 to 12 percent slopes	470	0.1
31	Afton silty clay loam, 0 to 2 percent slopes	3,790	1.0
33D	Steinauer clay loam, 9 to 14 percent slopes	1,240	0.3
33F	Steinauer clay loam, 14 to 25 percent slopes	1,930	0.5
33G	Steinauer clay loam, 25 to 40 percent slopes	5,340	1.5
54	Zook silty clay loam, 0 to 2 percent slopes	680	0.2
72B	Estherville loam, 2 to 5 percent slopes	340	0.1
72C	Estherville loam, 5 to 9 percent slopes	315	0.1
77B	Sac silty clay loam, loam substratum, 2 to 5 percent slopes	2,380	0.6
77B2	Sac silty clay loam, loam substratum, 2 to 5 percent slopes, moderately eroded	2,850	0.8
77C	Sac silty clay loam, loam substratum, 5 to 9 percent slopes	375	0.1
77C2	Sac silty clay loam, loam substratum, 5 to 9 percent slopes, moderately eroded	1,700	0.5
78B	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes	1,450	0.4
78B2	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes, moderately eroded	2,375	0.6
78C	Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes	410	0.1
78C2	Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes, moderately eroded	2,175	0.6
91	Primghar silty clay loam, 0 to 2 percent slopes	5,800	1.6
91B	Primghar silty clay loam, 1 to 4 percent slopes	19,570	5.3
92	Marcus silty clay loam, 0 to 2 percent slopes	21,455	5.9
96	Turlin loam, 0 to 2 percent slopes	915	0.2
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes	1,605	0.4
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes	675	0.2
133	Colo silty clay loam, 0 to 2 percent slopes	14,305	3.9
135	Coland clay loam, 0 to 2 percent slopes	4,755	1.3
189	Omadi silty clay loam, 0 to 2 percent slopes	1,730	0.5
309	Allendorf silty clay loam, 0 to 2 percent slopes	1,390	0.4
309B	Allendorf silty clay loam, 2 to 5 percent slopes	360	0.1
310	Galva silty clay loam, 0 to 2 percent slopes	8,875	2.4
310B	Galva silty clay loam, 2 to 5 percent slopes	110,720	30.5
310B2	Galva silty clay loam, 2 to 5 percent slopes, moderately eroded	17,625	4.8
310C	Galva silty clay loam, 5 to 9 percent slopes	23,765	6.5
310C2	Galva silty clay loam, 5 to 9 percent slopes, moderately eroded	34,935	9.5
310D2	Galva silty clay loam, 9 to 14 percent slopes, moderately eroded	3,805	1.0
354	Aquolls, ponded	40	*
428B	Ely silty clay loam, 1 to 4 percent slopes	580	0.2
433D	Storden loam, 9 to 14 percent slopes	245	0.1
433F	Storden loam, 14 to 25 percent slopes	305	0.1
433G	Storden loam, 25 to 50 percent slopes	6,010	1.6
485	Spillville loam, 0 to 2 percent slopes	1,710	0.5
485B	Spillville loam, 1 to 4 percent slopes	1,685	0.5
505	Sperry silty clay loam, 0 to 1 percent slopes	250	0.1
577B2	Everly clay loam, 2 to 5 percent slopes, moderately eroded	655	0.2
577C	Everly clay loam, 5 to 9 percent slopes	320	0.1
577C2	Everly clay loam, 5 to 9 percent slopes, moderately eroded	970	0.3
577D2	Everly clay loam, 9 to 14 percent slopes, moderately eroded	1,005	0.3
585B	Spillville-Coland complex, 1 to 5 percent slopes	1,220	0.3
633G	Steinauer-Steinauer Variant clay loams, 20 to 50 percent slopes	1,380	0.4
739G	Steinauer-Hawick complex, 25 to 40 percent slopes	790	0.2
740C	Hawick sandy loam, 2 to 9 percent slopes	945	0.3
740E	Hawick sandy loam, 9 to 18 percent slopes	1,460	0.4
740G	Hawick sandy loam, 18 to 35 percent slopes	1,660	0.5

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
810	Galva silty clay loam, benches, 0 to 2 percent slopes	6,300	1.7
810B	Galva silty clay loam, benches, 2 to 5 percent slopes	2,770	0.8
810C2	Galva silty clay loam, benches, 5 to 9 percent slopes, moderately eroded	805	0.2
878B	Ocheyedan loam, 2 to 5 percent slopes	320	0.1
878C2	Ocheyedan loam, 5 to 9 percent slopes, moderately eroded	210	0.1
1609	Fluvaquents-Omadi complex, channeled, 0 to 2 percent slopes	2,965	0.8
1639G	Storden-Hawick complex, 25 to 50 percent slopes	330	0.1
1658C	Terril-Coland complex, channeled, 2 to 9 percent slopes	2,095	0.6
1785	Spillco loam, channeled, 0 to 2 percent slopes	1,085	0.3
5010	Pits, sand and gravel	665	0.2
5040	Orthents, loamy	1,230	0.3
	Water	1,295	0.4
	Total	366,720	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
8B	Judson silty clay loam, 2 to 5 percent slopes
11B	Colo-Judson silty clay loams, 0 to 5 percent slopes (where drained)
26	Kennebec silty clay loam, 0 to 2 percent slopes
27	Terril loam, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
31	Afton silty clay loam, 0 to 2 percent slopes (where drained)
54	Zook silty clay loam, 0 to 2 percent slopes (where drained)
77B	Sac silty clay loam, loam substratum, 2 to 5 percent slopes
77B2	Sac silty clay loam, loam substratum, 2 to 5 percent slopes, moderately eroded
78B	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes
78B2	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes, moderately eroded
91	Primghar silty clay loam, 0 to 2 percent slopes
91B	Primghar silty clay loam, 1 to 4 percent slopes
92	Marcus silty clay loam, 0 to 2 percent slopes (where drained)
96	Turlin loam, 0 to 2 percent slopes
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
133	Colo silty clay loam, 0 to 2 percent slopes (where drained)
135	Coland clay loam, 0 to 2 percent slopes (where drained)
189	Omadi silty clay loam, 0 to 2 percent slopes
309	Allendorf silty clay loam, 0 to 2 percent slopes
309B	Allendorf silty clay loam, 2 to 5 percent slopes
310	Galva silty clay loam, 0 to 2 percent slopes
310B	Galva silty clay loam, 2 to 5 percent slopes
310B2	Galva silty clay loam, 2 to 5 percent slopes, moderately eroded
428B	Ely silty clay loam, 1 to 4 percent slopes
485	Spillville loam, 0 to 2 percent slopes
485B	Spillville loam, 1 to 4 percent slopes
505	Sperry silty clay loam, 0 to 1 percent slopes (where drained)
577B2	Everly clay loam, 2 to 5 percent slopes, moderately eroded
810	Galva silty clay loam, benches, 0 to 2 percent slopes
810B	Galva silty clay loam, benches, 2 to 5 percent slopes
878B	Ocheyedan loam, 2 to 5 percent slopes

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
1C3------------- Ida	IIIe	102	37	77	4.7	2.7	4.8	4.8
1D3------------- Ida	IIIe	93	34	70	4.3	2.3	4.3	4.3
1E3------------- Ida	IVe	76	28	57	3.6	1.3	3.5	3.5
1G-------------- Ida	VIIe	---	---	---	---	0.5	---	---
8B-------------- Judson	IIe	133	50	100	6.3	3.9	8.0	8.6
11B------------- Colo-Judson	IIw	121	45	91	---	4.2	6.2	7.6
26-------------- Kennebec	I	133	50	99	5.5	4.2	---	---
27-------------- Terril	I	132	49	100	5.5	4.2	8.0	8.3
27B------------- Terril	IIe	129	48	97	5.4	4.2	8.0	8.3
27C------------- Terril	IIIe	124	47	93	5.2	4.0	7.6	8.0
28B------------- Dickman	IIIe	65	24	49	3.2	2.0	3.6	3.9
28D------------- Dickman	IVe	51	20	38	2.6	2.0	3.4	3.4
31-------------- Afton	IIw	130	49	98	3.9	3.7	5.8	---
33D------------- Steinauer	IIIe	95	36	71	4.5	2.6	5.0	---
33F------------- Steinauer	VIe	---	---	---	---	1.8	3.1	---
33G------------- Steinauer	VIIe	---	---	---	---	0.8	---	---
54-------------- Zook	IIw	115	42	86	3.8	4.0	6.2	---
72B------------- Estherville	IIIs	84	29	63	3.4	2.0	3.0	2.5
72C------------- Estherville	IVs	79	28	59	2.9	1.5	2.5	2.5

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
77B------------- Sac	IIe	122	46	92	5.1	3.3	5.6	5.6
77B2------------ Sac	IIe	118	44	89	5.0	3.3	5.5	5.5
77C------------- Sac	IIIe	117	44	88	4.9	3.3	5.3	5.3
77C2------------ Sac	IIIe	113	42	85	4.8	3.3	5.1	5.1
78B------------- Sac	IIe	122	46	92	5.1	3.3	5.6	---
78B2------------ Sac	IIe	118	44	89	5.0	3.3	5.5	---
78C------------- Sac	IIIe	117	44	88	4.9	3.3	5.3	---
78C2------------ Sac	IIIe	113	42	85	4.8	3.3	5.1	---
91-------------- Primghar	I	140	53	105	5.6	3.8	6.5	6.5
91B------------- Primghar	IIe	137	51	103	5.5	3.7	6.3	6.3
92-------------- Marcus	IIw	135	51	101	4.1	3.7	6.3	6.3
96-------------- Turlin	IIw	121	47	92	6.1	4.1	8.3	8.3
108------------- Wadena	IIs	90	31	69	4.1	2.6	4.8	4.8
108B------------ Wadena	IIe	87	30	67	4.0	2.6	4.6	4.7
133------------- Colo	IIw	127	45	90	3.6	3.7	6.0	7.0
135------------- Coland	IIw	126	44	95	4.1	4.1	7.6	7.6
189------------- Omadi	I	125	43	86	4.8	3.3	5.6	5.0
309------------- Allendorf	IIs	98	41	83	4.6	3.7	6.6	7.2
309B------------ Allendorf	IIe	95	40	80	4.5	3.7	6.5	7.0
310------------- Galva	I	132	50	99	5.5	3.7	6.1	6.1

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
310B------------ Galva	IIe	129	48	97	5.4	3.6	6.0	6.0
310B2----------- Galva	IIe	125	47	94	5.3	3.5	5.8	5.8
310C------------ Galva	IIIe	124	47	93	5.2	3.4	5.6	5.6
310C2----------- Galva	IIIe	120	45	90	5.0	3.3	5.5	5.5
310D2----------- Galva	IIIe	111	42	83	4.7	2.7	5.0	5.0
354**. Aquolls								
428B------------ Ely	IIe	131	50	98	6.0	3.6	8.4	8.8
433D------------ Storden	IIIe	95	36	69	4.1	2.4	4.9	5.0
433F------------ Storden	VIe	---	---	---	---	1.6	3.1	3.7
433G------------ Storden	VIIe	---	---	---	---	1.3	---	---
485------------- Spillville	IIw	112	39	84	5.4	3.6	5.9	8.6
485B------------ Spillville	IIe	109	38	82	5.3	4.1	7.1	8.5
505------------- Sperry	IIIw	96	38	72	3.0	3.0	4.9	---
577B2----------- Everly	IIe	108	43	81	4.8	3.3	5.4	5.5
577C------------ Everly	IIIe	107	43	77	4.9	3.3	5.3	5.3
577C2----------- Everly	IIIe	103	39	71	4.7	3.3	5.1	5.1
577D2----------- Everly	IIIe	94	38	71	4.3	2.7	4.5	4.5
585B------------ Spillville-Coland	IIIw	137	44	96	4.1	3.6	6.6	8.2
633G------------ Steinauer-Steinauer Variant	VIIe	---	---	---	---	0.5	---	---

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Bromegrass-alfalfa hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
		Bu	Bu	Bu	Tons	AUM*	AUM*	AUM*
739G------------ Steinauer-Hawick	VIIe	---	---	---	---	0.5	---	---
740C------------ Hawick	IVs	35	15	40	3.5	1.5	---	3.0
740E------------ Hawick	VIs	---	---	---	---	1.0	---	2.0
740G------------ Hawick	VIIs	---	---	---	---	0.6	---	---
810------------- Galva	I	130	49	98	5.5	3.7	6.1	6.1
810B------------ Galva	IIe	127	48	95	5.3	3.7	6.0	6.0
810C2----------- Galva	IIIe	120	45	90	5.0	3.3	5.3	5.5
878B------------ Ocheyedan	IIe	109	39	79	4.4	3.1	5.7	5.8
878C2----------- Ocheyedan	IIIe	100	38	75	4.2	2.7	5.3	5.3
1609------------ Fluvaquents-Omadi	Vw	---	---	---	---	---	---	---
1639G----------- Storden-Hawick	VIIe	---	---	---	---	1.2	---	---
1658C----------- Terril-Coland	Vw	---	---	---	---	3.5	---	---
1785------------ Spillco	Vw	---	---	---	---	2.5	---	---
5010**. Pits								
5040**. Orthents								

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1C3, 1D3, 1E3, 1G-Ida	Silver buffaloberry, American plum.	Rocky Mountain juniper, hackberry, Siberian peashrub, eastern redcedar, Russian olive.	Siberian elm, green ash, ponderosa pine, thornless honeylocust.	---	---
8B----------------Judson	---	Siberian peashrub, lilac.	Bur oak, hackberry, eastern redcedar, blue spruce, Russian olive.	Ponderosa pine, thornless honeylocust, green ash.	---
11B*:					
Colo-------------	---	Redosier dogwood, American plum.	White fir, white spruce, hackberry, Amur maple, tall purple willow.	Green ash, golden willow.	Silver maple, eastern cottonwood.
Judson-----------	---	Siberian peashrub, lilac.	Bur oak, hackberry, eastern redcedar, blue spruce, Russian olive.	Ponderosa pine, thornless honeylocust, green ash.	---
26----------------Kennebec	Peking cotoneaster	American plum, lilac, Siberian peashrub.	Ponderosa pine, eastern redcedar, Manchurian crabapple.	Green ash, golden willow, hackberry, thornless honeylocust.	Eastern cottonwood.
27, 27B, 27C------Terril	---	Siberian peashrub, American plum, lilac.	Russian olive, hackberry, blue spruce, bur oak, eastern redcedar.	Ponderosa pine, thornless honeylocust, green ash.	---
28B, 28D----------Dickman	---	Rocky Mountain juniper, eastern redcedar, Russian olive, ponderosa pine.	Siberian elm------	---	---
31----------------Afton	Lilac-------------	Siberian peashrub	Eastern redcedar, hackberry, Russian olive, ponderosa pine, blue spruce.	Golden willow, thornless honeylocust, green ash.	Eastern cottonwood.
33D---------------Steinauer	American plum, silver buffaloberry.	Eastern redcedar, Siberian peashrub, Russian olive, Rocky Mountain juniper, hackberry.	Ponderosa pine, Siberian elm, thornless honeylocust, green ash.	---	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
33F, 33G. Steinauer					
54. Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Thornless honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
72B, 72C. Estherville	---	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, Russian olive.	Siberian elm	---	---
77B, 77B2, 77C, 77C2, 78B, 78B2, 78C, 78C2. Sac	---	Siberian peashrub, American plum, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian olive.	Ponderosa pine, thornless honeylocust, green ash.	---
91, 91B. Primghar	Peking cotoneaster	American plum, lilac, Siberian peashrub.	Eastern redcedar, ponderosa pine, Manchurian crabapple.	Golden willow, thornless honeylocust, green ash, hackberry.	Eastern cottonwood.
92. Marcus	Lilac	Siberian peashrub	Eastern redcedar, blue spruce, ponderosa pine, hackberry.	Green ash, thornless honeylocust, golden willow, silver maple.	Eastern cottonwood.
96. Turlin	---	Redosier dogwood, lilac.	Northern white-cedar, Amur maple, blue spruce, white spruce.	Hackberry, green ash, Austrian pine, eastern white pine.	Silver maple.
108, 108B. Wadena	Siberian peashrub, lilac.	Eastern redcedar, Russian olive, hackberry, Manchurian crabapple.	Jack pine, honeysuckle, bur oak, green ash, eastern white pine.	---	---
133. Colo	---	Redosier dogwood, American plum.	White fir, white spruce, hackberry, Amur maple, tall purple willow.	Green ash, golden willow.	Silver maple, eastern cottonwood.
135. Coland	---	Redosier dogwood, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
189. Omadi	---	Siberian peashrub, lilac.	Eastern redcedar, ponderosa pine, Russian olive, bur oak.	Golden willow, green ash, hackberry, thornless honeylocust.	Eastern cottonwood.
309, 309B. Allendorf	---	American plum, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian olive.	Thornless honeylocust, ponderosa pine, green ash.	---
310, 310B, 310B2, 310C, 310C2, 310D2. Galva	---	American plum, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian olive.	Thornless honeylocust, ponderosa pine, green ash.	---
354*. Aquolls					
428B. Ely	---	Autumn olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar	Pin oak, eastern white pine, Austrian pine, green ash, hackberry, thornless honeylocust.	Eastern cottonwood.
433D, 433F, 433G. Storden	American plum	Eastern redcedar, hackberry, Siberian peashrub.	Thornless honeylocust, green ash, Russian olive.	Siberian elm	---
485, 485B. Spillville	---	Redosier dogwood, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
505. Sperry	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, thornless honeylocust, silver maple.	Eastern cottonwood.
577B2, 577C, 577C2, 577D2. Everly	---	American plum, Siberian peashrub, lilac.	Hackberry, blue spruce, bur oak, Russian olive, eastern redcedar.	Ponderosa pine, thornless honeylocust, green ash.	---
585B*: Spillville	---	Redosier dogwood, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
585B*: Coland	---	Redosier dogwood, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
633G*: Steinauer.					
Steinauer Variant	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian olive.	Thornless honeylocust.	---
739G*: Steinauer.					
Hawick	Siberian peashrub	Late lilac, honeysuckle, Persian lilac, common chokecherry, Manchurian crabapple, northern white-cedar, sargent crabapple, silver buffaloberry, birchleaf buckthorn.	Jack pine, Austrian pine, eastern redcedar, green ash, thornless honeylocust, Russian olive, ponderosa pine, white spruce, silver maple.	Eastern white pine, red pine, Siberian elm, Scotch pine, eastern cottonwood.	---
740C, 740E, 740G-- Hawick	Siberian peashrub	Late lilac, honeysuckle, Persian lilac, common chokecherry, Manchurian crabapple, northern white-cedar, sargent crabapple, silver buffaloberry, birchleaf buckthorn.	Jack pine, Austrian pine, eastern redcedar, green ash, thornless honeylocust, Russian olive, ponderosa pine, white spruce, silver maple.	Eastern white pine, red pine, Siberian elm, Scotch pine, eastern cottonwood.	---
810, 810B, 810C2-- Galva	---	American plum, Siberian peashrub, lilac.	Eastern redcedar, blue spruce, bur oak, hackberry, Russian olive.	Thornless honeylocust, ponderosa pine, green ash.	---
878B-- Ocheyedan	---	Lilac, Siberian peashrub, American plum.	Eastern redcedar, bur oak, blue spruce, Russian olive, hackberry.	Thornless honeylocust, green ash, ponderosa pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
878C2. Ocheyedan					
1609*: Fluvaquents.					
Omadi	---	Lilac, American plum, Siberian peashrub.	Eastern redcedar, bur oak, Russian olive, blue spruce, hackberry.	Ponderosa pine, green ash, thornless honeylocust.	---
1639G*: Storden	American plum	Eastern redcedar, hackberry, Siberian peashrub.	Thornless honeylocust, green ash, Russian olive.	Siberian elm	---
Hawick	Siberian peashrub	Late lilac, honeysuckle, Persian lilac, common chokecherry, Manchurian crabapple, northern white-cedar, sargent crabapple, silver buffaloberry, birchleaf buckthorn.	Jack pine, Austrian pine, eastern redcedar, green ash, thornless honeylocust, Russian olive, ponderosa pine, white spruce, silver maple.	Eastern white pine, red pine, Siberian elm, Scotch pine, eastern cottonwood.	---
1658C*: Terril	---	Siberian peashrub, American plum, lilac.	Russian olive, hackberry, blue spruce, bur oak, eastern redcedar.	Ponderosa pine, thornless honeylocust, green ash.	---
Coland	---	Redosier dogwood, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1785. Spillco					
5010*. Pits					
5040*. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1C3 Ida	Slight	Slight	Severe: slope.	Slight	Slight.
1D3 Ida	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
1E3 Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
1G Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.	Severe: slope.
8B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
11B*:					
Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
26 Kennebec	Severe: flooding.	Slight	Slight	Slight	Slight.
27 Terril	Slight	Slight	Slight	Slight	Slight.
27B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
27C Terril	Slight	Slight	Severe: slope.	Slight	Slight.
28B Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
28D Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
31 Afton	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
33D Steinauer	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
33F Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
33G Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
54 Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
72B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
72C Estherville	Slight	Slight	Severe: slope.	Slight	Moderate: droughty.
77B, 77B2 Sac	Slight	Slight	Moderate: slope.	Slight	Slight.
77C, 77C2 Sac	Slight	Slight	Severe: slope.	Slight	Slight.
78B, 78B2 Sac	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
78C, 78C2 Sac	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
91 Primghar	Slight	Slight	Slight	Slight	Slight.
91B Primghar	Slight	Slight	Moderate: slope.	Slight	Slight.
92 Marcus	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
96 Turlin	Severe: flooding, excess humus.	Severe: excess humus.	Severe: excess humus.	Severe: excess humus.	Slight.
108 Wadena	Slight	Slight	Slight	Slight	Slight.
108B Wadena	Slight	Slight	Moderate: slope.	Slight	Slight.
133 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
135 Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
189 Omadi	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
309 Allendorf	Slight	Slight	Slight	Slight	Slight.
309B Allendorf	Slight	Slight	Moderate: slope.	Slight	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
310------------------- Galva	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
310B, 310B2----------- Galva	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
310C, 310C2----------- Galva	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
310D2----------------- Galva	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
428B------------------ Ely	Moderate: wetness.	Moderate: wetness.	Moderate: slope, wetness.	Slight----------	Slight.
433D------------------ Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
433F------------------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
433G------------------ Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
485------------------- Spillville	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
485B------------------ Spillville	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
505------------------- Sperry	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
577B2----------------- Everly	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
577C, 577C2----------- Everly	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
577D2----------------- Everly	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
585B*:					
Spillville-----------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Coland---------------	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
633G*:					
Steinauer------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Steinauer Variant----	Severe: slope, wetness, percs slowly.	Severe: slope, percs slowly.	Severe: slope, wetness.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
739G*:					
Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
740C Hawick	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
740E Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
740G Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
810 Galva	Slight	Slight	Slight	Slight	Slight.
810B Galva	Slight	Slight	Moderate: slope.	Slight	Slight.
810C2 Galva	Slight	Slight	Severe: slope.	Slight	Slight.
878B Ocheyedan	Slight	Slight	Moderate: slope.	Slight	Slight.
878C2 Ocheyedan	Slight	Slight	Severe: slope.	Slight	Slight.
1609*:					
Fluvaquents.					
Omadi	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
1639G*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1658C*:					
Terril	Slight	Slight	Severe: slope.	Slight	Slight.
Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
1785 Spillco	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1C3, 1D3----------- Ida	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1E3---------------- Ida	Fair	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.
1G----------------- Ida	Very poor.	Very poor.	Good	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
8B----------------- Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B*:										
Colo---------------	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Judson-------------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
26----------------- Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
27, 27B------------ Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
27C---------------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
28B, 28D----------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
31----------------- Afton	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
33D, 33F----------- Steinauer	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
33G---------------- Steinauer	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
54----------------- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
72B, 72C----------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
77B, 77B2---------- Sac	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
77C, 77C2---------- Sac	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
78B, 78B2---------- Sac	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
78C, 78C2---------- Sac	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
91, 91B Primghar	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
92 Marcus	Good	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Fair.
96 Turlin	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
108, 108B Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
133 Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
135 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
189 Omadi	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
309, 309B Allendorf	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
310, 310B, 310B2 Galva	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
310C, 310C2, 310D2 Galva	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
428B Ely	Good	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
433D Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
433F, 433G Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
485 Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
485B Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
505 Sperry	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
577B2 Everly	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
577C, 577C2, 577D2 Everly	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
585B*: Spillville	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
585B*: Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
633G*:										
Steinauer	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Steinauer Variant	Very poor.	Poor	Fair	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
739G*:										
Steinauer	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
740C, 740E Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
740G Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
810, 810B Galva	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
810C2 Galva	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
878B Ocheyedan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
878C2 Ocheyedan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1609*: Fluvaquents.										
Omadi	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1639G*:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
1658C*:										
Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1785 Spillco	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1C3 Ida	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
1D3 Ida	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
1E3, 1G Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action.	Severe: slope.
8B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
11B*:						
Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
26 Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
27, 27B Terril	Slight	Slight	Slight	Slight	Severe: low strength.	Slight.
27C Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
28B Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
28D Dickman	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
31 Afton	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: shrink-swell, low strength, flooding.	Moderate: wetness, flooding.
33D Steinauer	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
33F, 33G Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
54 Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
72B Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
72C Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
77B, 77B2 Sac	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
77C, 77C2 Sac	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
78B, 78B2 Sac	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
78C, 78C2 Sac	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
91, 91B Primghar	Moderate: wetness.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Slight.
92 Marcus	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
96 Turlin	Severe: cutbanks cave, excess humus.	Severe: flooding, low strength.	Severe: flooding.	Severe: flooding, low strength.	Moderate: low strength, flooding, frost action.	Slight.
108, 108B Wadena	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Slight.
133 Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
135 Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
189 Omadi	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
309, 309B: Allendorf	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
310, 310B, 310B2: Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
310C, 310C2: Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
310D2: Galva	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
354*. Aquolls						
428B: Ely	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: frost action, low strength.	Slight.
433D: Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
433F, 433G: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
485: Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
485B: Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
505: Sperry	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: shrink-swell, low strength, ponding.	Severe: ponding.
577B2: Everly	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
577C, 577C2: Everly	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
577D2: Everly	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
585B*:						
Spillville	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
585B*:						
Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
633G*:						
Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Steinauer Variant	Severe: wetness, slope.	Severe: wetness, shrink-swell, slope.	Severe: wetness, slope, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: slope.
739G*:						
Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
740C Hawick	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
740E Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
740G Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
810, 810B Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
810C2 Galva	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
878B Ocheyedan	Slight	Slight	Slight	Slight	Moderate: frost action.	Slight.
878C2 Ocheyedan	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
1609*: Fluvaquents.						
Omadi	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
1639G*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1639G*:						
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1658C*:						
Terril	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.	Slight.
Coland	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.
1785 Spillco	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
5010*. Pits						
5040*. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1C3 Ida	Slight	Severe: slope.	Slight	Slight	Good.
1D3 Ida	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
1E3, 1G Ida	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
8B Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
11B*:					
Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
26 Kennebec	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Fair: too clayey.
27 Terril	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
27B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
27C Terril	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
28B Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
28D Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31 Afton	Severe: percs slowly, wetness, flooding.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
33D Steinauer	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
33F, 33G Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
54 Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
72B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
72C Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
77B, 77B2 Sac	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
77C, 77C2 Sac	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
78B, 78B2 Sac	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
78C, 78C2 Sac	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
91, 91B Primghar	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack.
92 Marcus	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
96 Turlin	Severe: wetness.	Severe: seepage, flooding, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: hard to pack.
108, 108B Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
133 Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
135 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
189 Omadi	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
309, 309B----------- Allendorf	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
310----------------- Galva	Slight-----------	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
310B, 310B2--------- Galva	Slight-----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
310C, 310C2--------- Galva	Slight-----------	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
310D2--------------- Galva	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
354*. Aquolls					
428B---------------- Ely	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
433D---------------- Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
433F, 433G---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
485----------------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
485B---------------- Spillville	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.
505----------------- Sperry	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
577B2--------------- Everly	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
577C, 577C2--------- Everly	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
577D2--------------- Everly	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
585B*:					
Spillville---------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
585B*:					
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
633G*:					
Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Steinauer Variant	Severe: wetness, percs slowly, slope.	Severe: slope.	Severe: wetness, slope, too clayey.	Severe: wetness, slope.	Poor: too clayey, hard to pack, slope.
739G*:					
Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
740C Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
740E Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
740G Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
810 Galva	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
810B Galva	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
810C2 Galva	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
878B Ocheyedan	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
878C2 Ocheyedan	Slight	Severe: slope.	Slight	Slight	Good.
1609*: Fluvaquents.					

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1609*:					
Omadi	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
1639G*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
1658C*:					
Terril	Slight	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
1785 Spillco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, seepage.	Severe: flooding, wetness.	Fair: wetness.
5010*. Pits					
5040*. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1C3 Ida	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
1D3 Ida	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
1E3 Ida	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1G Ida	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
8B Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
11B*:				
Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
26 Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
27, 27B, 27C Terril	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
28B, 28D Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
31 Afton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
33D Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, large stones, slope.
33F Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
33G Steinauer	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
54 Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
72B, 72C Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
77B, 77B2, 77C, 77C2-- Sac	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
78B, 78B2, 78C, 78C2-- Sac	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
91, 91B-- Primghar	Good--	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
92-- Marcus	Fair: low strength, shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
96-- Turlin	Good--	Improbable: excess fines.	Improbable: excess fines.	Good.
108, 108B-- Wadena	Good--	Probable--	Probable--	Poor: small stones, area reclaim.
133-- Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
135-- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
189-- Omadi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
309, 309B-- Allendorf	Good--	Probable--	Probable--	Poor: area reclaim.
310, 310B, 310B2, 310C, 310C2-- Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
310D2-- Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
354*. Aquolls				
428B-- Ely	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
433D-- Storden	Good--	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
433F-- Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
433G-- Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
485, 485B-- Spillville	Good--	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
505: Sperry	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
577B2, 577C, 577C2: Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
577D2: Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
585B*:				
Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
633G*:				
Steinauer	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Steinauer Variant	Poor: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
739G*:				
Steinauer	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
740C, 740E: Hawick	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
740G: Hawick	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
810, 810B, 810C2: Galva	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
878B, 878C2: Ocheyedan	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1609*: Fluvaquents.				
Omadi	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1639G*:				
Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick	Poor: slope.	Probable	Probable	Poor: too sandy, small stones, area reclaim.
1658C*:				
Terril	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1785 Spillco	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
5010*. Pits				
5040*. Orthents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
1C3: Ida	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
1D3, 1E3, 1G: Ida	Severe: slope.	Severe: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
8B: Judson	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
11B*:						
Colo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
Judson	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
26: Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
27: Terril	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
27B, 27C: Terril	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
28B: Dickman	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
28D: Dickman	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
31: Afton	Slight	Severe: wetness.	Severe: slow refill.	Flooding, frost action.	Wetness, erodes easily.	Wetness, erodes easily.
33D, 33F, 33G: Steinauer	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope	Slope, rooting depth.
54: Zook	Slight	Severe: hard to pack, wetness.	Severe: slow refill.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Wetness, percs slowly.
72B, 72C: Estherville	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Too sandy	Droughty.
77B, 77B2, 77C, 77C2: Sac	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
78B, 78B2, 78C, 78C2 Sac	Moderate: seepage, slope.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily, rooting depth.
91, 91B Primghar	Moderate: seepage.	Moderate: hard to pack, wetness.	Moderate: deep to water, slow refill.	Deep to water	Erodes easily	Erodes easily.
92 Marcus	Moderate: seepage.	Severe: wetness.	Severe: slow refill.	Frost action	Wetness, erodes easily.	Wetness, erodes easily.
96 Turlin	Moderate: seepage.	Severe: piping, excess humus.	Severe: cutbanks cave.	Deep to water	Favorable	Favorable.
108, 108B Wadena	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy	Favorable.
133 Colo	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
135 Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
189 Omadi	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
309, 309B Allendorf	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Erodes easily, too sandy.	Erodes easily.
310 Galva	Moderate: seepage.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
310B, 310B2, 310C, 310C2 Galva	Moderate: seepage, slope.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
310D2 Galva	Severe: slope.	Slight	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
354*. Aquolls						
428B Ely	Moderate: seepage, slope.	Moderate: wetness, piping.	Moderate: deep to water, slow refill.	Frost action	Erodes easily, wetness.	Erodes easily.
433D, 433F, 433G Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
485 Spillville	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
485B: Spillville	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
505: Sperry	Slight	Severe: ponding.	Severe: slow refill.	Ponding, percs slowly, frost action.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
577B2, 577C, 577C2: Everly	Moderate: seepage, slope.	Moderate: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
577D2: Everly	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope	Slope.
585B*:						
Spillville	Moderate: seepage, slope.	Moderate: thin layer, piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action.	Wetness	Wetness.
633G*:						
Steinauer	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope	Slope, rooting depth.
Steinauer Variant	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Severe: no water.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Wetness, slope, percs slowly.
739G*:						
Steinauer	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope	Slope, rooting depth.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
740C: Hawick	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Too sandy, soil blowing.	Droughty.
740E, 740G: Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
810: Galva	Moderate: seepage.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
810B, 810C2: Galva	Moderate: seepage, slope.	Slight	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
878B, 878C2: Ocheyedan	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Terraces and diversions	Grassed waterways
1609*: Fluvaquents.						
Omadi	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Erodes easily	Erodes easily.
1639G*: Storden	Severe: slope.	Moderate: piping.	Severe: no water.	Deep to water	Slope, erodes easily.	Slope, erodes easily.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, too sandy, soil blowing.	Slope, droughty.
1658C*: Terril	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Favorable	Favorable.
Coland	Severe: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding, frost action, slope.	Wetness	Wetness.
1785 Spillco	Moderate: seepage.	Moderate: piping, wetness.	Moderate: deep to water, slow refill.	Deep to water	Favorable	Favorable.
5010*. Pits						
5040*. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1C3, 1D3, 1E3, 1G------------- Ida	0-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
8B--------------- Judson	0-32	Silty clay loam	CL, ML	A-6, A-7	0	100	100	100	95-100	35-50	10-25
	32-48	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	48-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
11B*:											
Colo------------	0-15	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	15-47	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	47-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Judson----------	0-32	Silty clay loam	CL, ML	A-6, A-7	0	100	100	100	95-100	35-50	10-25
	32-48	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	48-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
26--------------- Kennebec	0-42	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
	42-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
27, 27B, 27C----- Terril	0-32	Loam-------------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	32-60	Clay loam, loam, sandy loam.	CL, SC, SM-SC, CL-ML	A-6, A-4	0-5	95-100	90-100	65-95	35-85	20-40	5-20
28B, 28D--------- Dickman	0-16	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	16-32	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	32-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
31--------------- Afton	0-31	Silty clay loam	MH, CH	A-7	0	100	100	100	95-100	50-65	20-35
	31-47	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	100	95-100	40-60	20-35
	47-60	Clay loam, silt loam, silty clay loam.	CL	A-6, A-7	0	100	95-100	80-100	60-90	35-50	20-30
33D, 33F, 33G---- Steinauer	0-5	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	5-11	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	11-60	Loam, clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	60-75	25-55	10-30
54--------------- Zook	0-17	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	17-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
72B, 72C--------- Estherville	0-9	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	80-100	50-75	50-60	25-40	4-15
	9-20	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	20-60	Coarse sand, gravelly coarse sand, gravelly loamy sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
77B, 77B2, 77C, 77C2------------ Sac	0-18	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	18-34	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	34-60	Loam-------------	CL, CL-ML	A-6, A-4	2-5	95-100	90-100	75-90	65-80	25-40	5-20
78B, 78B2, 78C, 78C2------------ Sac	0-14	Silty clay loam	CL, ML, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	14-35	Silty clay loam	CL, ML, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	35-60	Clay loam--------	CL	A-6, A-7	2-5	95-100	90-100	75-95	65-80	35-50	15-30
91, 91B---------- Primghar	0-17	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-60	20-30
	17-36	Silty clay loam	CL, CH	A-7	0	100	100	95-100	90-100	40-55	20-30
	36-60	Silt loam--------	CL	A-6	0	100	100	95-100	90-100	30-40	11-20
92--------------- Marcus	0-19	Silty clay loam	MH, CH	A-7	0	100	100	95-100	90-100	50-65	20-35
	19-46	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	20-35
	46-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	95-100	85-95	30-40	15-25
96--------------- Turlin	0-33	Loam-------------	OL, ML, CL	A-4, A-6	0	100	100	95-100	60-70	30-40	5-15
	33-60	Loam, silt loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	55-70	25-35	5-15
108, 108B-------- Wadena	0-12	Loam-------------	ML	A-4	0	95-100	90-100	75-95	50-65	25-40	2-10
	12-27	Loam, sandy loam, sandy clay loam.	SM-SC, CL-ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	27-60	Stratified gravelly coarse sand to gravelly sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	35-95	10-80	2-10	---	NP
133-------------- Colo	0-15	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	15-47	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	47-60	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
135-------------- Coland	0-8	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	8-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
189-------------- Omadi	0-22	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	10-15
	22-60	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	3-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
309, 309B-------- Allendorf	0-13	Silty clay loam	CL	A-6	0	95-100	95-100	95-100	85-95	30-40	10-20
	13-35	Silty clay loam, silt loam.	CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	80-95	25-40	5-20
	35-39	Loam, sandy loam	ML, SM	A-4	0-5	85-100	85-100	65-90	40-60	25-35	3-10
	39-60	Gravelly loamy sand, gravelly sand, sand.	SM, SP-SM, SP	A-1	2-10	60-95	40-95	20-40	3-25	---	NP
310, 310B, 310B2, 310C, 310C2, 310D2----------- Galva	0-17	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	17-33	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	33-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	85-100	35-50	15-25
	60-65	Clay loam, loam	CL	A-6	2-5	95-100	90-100	75-90	65-80	30-40	10-20
354*. Aquolls											
428B------------- Ely	0-28	Silty clay loam	CL, OL, OH, MH	A-7, A-6	0	100	100	95-100	95-100	30-55	10-25
	28-46	Silty clay loam	CL, ML	A-7, A-6	0	100	100	95-100	95-100	35-50	10-25
	46-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	90-100	85-100	25-40	10-20
433D, 433F, 433G- Storden	0-9	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
485, 485B-------- Spillville	0-48	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	48-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
505-------------- Sperry	0-11	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	11-18	Silt loam--------	CL	A-6	0	100	100	100	95-100	30-40	10-20
	18-50	Silty clay loam, silty clay.	CH	A-7	0	100	100	100	95-100	50-65	25-35
	50-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	100	95-100	40-50	20-30
577B2, 577C, 577C2, 577D2---- Everly	0-16	Clay loam--------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
	16-35	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	35-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
585B*: Spillville------	0-48	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	48-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
585B*: Coland----------	0-8	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	8-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
633G*:											
Steinauer--------	0-5	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	5-11	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	11-60	Loam, clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	60-75	25-55	10-30
Steinauer Variant---------	0-12	Clay loam--------	CL	A-6, A-7	0	95-100	90-100	90-100	60-80	35-50	20-30
	12-47	Silty clay, clay	CH	A-7	0	100	90-100	90-100	90-100	55-70	30-40
	47-60	Clay, silty clay	CH	A-7	0	100	90-100	90-100	90-100	55-70	35-45
739G*:											
Steinauer--------	0-6	Clay loam--------	CL	A-6, A-7	0-5	95-100	95-100	85-100	55-90	30-50	15-25
	6-10	Clay loam--------	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	70-90	30-55	12-30
	10-60	Loam, clay loam	CL, CH	A-6, A-7	0-5	95-100	95-100	90-100	60-75	25-55	10-30
Hawick-----------	0-9	Sandy loam-------	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
	9-20	Gravelly loamy sand, gravelly coarse sand, gravelly sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	20-60	Gravelly coarse sand, coarse sand, gravelly sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
740C, 740E, 740G-- Hawick	0-12	Sandy loam-------	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
	12-18	Gravelly loamy sand, gravelly coarse sand, gravelly sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	18-60	Very gravelly coarse sand, coarse sand, gravelly sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
810, 810B, 810C2-- Galva	0-23	Silty clay loam	ML, CL, MH, CH	A-7	0	100	100	95-100	90-100	40-55	15-25
	23-60	Silty clay loam	CL, ML	A-7	0	100	100	95-100	90-100	40-50	15-25
878B, 878B2------ Ocheyedan	0-15	Loam-------------	CL	A-6	0	100	100	75-90	65-80	30-40	10-15
	15-35	Sandy clay loam, sandy loam, loam.	SC, CL, SM-SC, CL-ML	A-4, A-6	0	100	100	60-80	35-55	25-40	5-15
	35-60	Sandy loam, sandy clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	100	100	85-95	50-90	25-40	5-15
1609*:											
Fluvaquents.											
Omadi-----------	0-22	Silty clay loam--	CL	A-6	0	100	100	95-100	90-100	30-40	10-15
	22-60	Silt loam--------	ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	3-15
1639G*:											
Storden----------	0-9	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1639G*:											
Hawick----------	0-9	Sandy loam-------	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
	9-20	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	20-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
1658C*:											
Terril----------	0-32	Loam-------------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	32-60	Clay loam, loam, sandy loam.	CL, SC, SM-SC, CL-ML	A-6, A-4	0-5	95-100	90-100	65-95	35-85	20-40	5-20
Coland----------	0-8	Clay loam--------	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
	8-60	Clay loam, silty clay loam.	CL	A-7, A-6	0	100	100	95-100	65-80	35-50	15-25
1785------------- Spillco	0-43	Loam-------------	CL	A-6	0	100	95-100	85-95	55-80	25-40	11-20
	43-60	Stratified sandy loam to clay loam.	CL-ML, CL, SM-SC, SC	A-4, A-6	0	95-100	90-95	70-85	35-75	15-30	5-15
5010*. Pits											
5040*. Orthents											

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group
	In	Pct	g/cc	In/hr	In/in	pH				
1C3, 1D3, 1E3, 1G: Ida	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	Low	0.43	5-4	4L
8B: Judson	0-32	27-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.28	5	7
	32-48	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.43		
	48-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate	0.43		
11B*:										
Colo	0-15	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.28	5	7
	15-47	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.28		
	47-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate	0.28		
Judson	0-32	27-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.28	5	7
	32-48	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.43		
	48-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate	0.43		
26: Kennebec	0-42	27-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate	0.32	5	7
	42-60	24-48	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate	0.43		
27, 27B, 27C: Terril	0-32	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	5	6
	32-60	15-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-8.4	Low	0.32		
28B, 28D: Dickman	0-16	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-7.3	Low	0.20	3	3
	16-32	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.8	Low	0.20		
	32-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-8.4	Low	0.15		
31: Afton	0-31	33-38	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	High	0.28	5	4
	31-47	25-35	1.25-1.30	0.2-0.6	0.18-0.20	6.6-8.4	High	0.43		
	47-60	25-30	1.30-1.45	0.2-2.0	0.14-0.16	7.4-8.4	Moderate	0.43		
33D, 33F, 33G: Steinauer	0-5	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate	0.32	5	4L
	5-11	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	Moderate	0.32		
	11-60	24-35	1.50-1.80	0.2-0.6	0.14-0.19	7.9-8.4	Moderate	0.32		
54: Zook	0-17	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High	0.28	5	7
	17-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High	0.28		
72B, 72C: Estherville	0-9	10-18	1.35-1.45	2.0-6.0	0.19-0.22	5.6-7.3	Low	0.20	3	5
	9-20	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20		
	20-60	0-8	1.50-1.65	>20	0.02-0.04	6.6-8.4	Low	0.10		
77B, 77B2, 77C, 77C2: Sac	0-18	32-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.32	5	4
	18-34	30-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43		
	34-60	22-26	1.50-1.65	0.6-2.0	0.16-0.18	6.6-8.4	Low	0.43		
78B, 78B2, 78C, 78C2: Sac	0-14	27-35	1.20-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.32	5	4
	14-35	27-35	1.20-1.30	0.6-2.0	0.18-0.20	6.1-7.3	Moderate	0.43		
	35-60	27-35	1.65-1.80	0.2-0.6	0.14-0.16	6.6-8.4	Moderate	0.32		
91, 91B: Primghar	0-17	35-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	High	0.28	5	4
	17-36	30-35	1.30-1.35	0.6-2.0	0.18-0.20	6.1-8.4	High	0.43		
	36-60	25-30	1.35-1.40	0.6-2.0	0.20-0.22	7.9-8.4	Moderate	0.43		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group
	In	Pct	g/cc	In/hr	In/in	pH				
92--------------- Marcus	0-19	36-40	1.30-1.35	0.2-0.6	0.21-0.23	6.1-7.8	High---------	0.28	5	4
	19-46	30-35	1.35-1.40	0.2-0.6	0.18-0.20	6.1-8.4	High---------	0.43		
	46-60	22-30	1.35-1.45	0.6-2.0	0.20-0.22	7.9-8.4	Moderate-----	0.43		
96--------------- Turlin	0-33	18-26	1.45-1.55	0.6-2.0	0.20-0.22	6.1-7.8	Low----------	0.24	5	6
	33-60	20-28	1.55-1.65	0.6-2.0	0.17-0.19	5.6-8.4	Low----------	0.32		
108, 108B-------- Wadena	0-12	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	4	5
	12-27	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	Low----------	0.32		
	27-60	1-5	1.55-1.65	>20	0.02-0.04	6.6-8.4	Low----------	0.10		
133-------------- Colo	0-15	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	15-47	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28		
	47-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.28		
135-------------- Coland	0-8	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	8-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		
189-------------- Omadi	0-22	27-30	1.30-1.40	0.6-2.0	0.22-0.24	6.6-8.4	Low----------	0.32	5	7
	22-60	18-30	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43		
309, 309B-------- Allendorf	0-13	27-32	1.25-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	4	7
	13-35	24-32	1.25-1.40	0.6-2.0	0.20-0.22	6.1-7.8	Moderate-----	0.43		
	35-39	18-24	1.40-1.50	0.6-2.0	0.15-0.19	6.1-7.8	Low----------	0.24		
	39-60	2-8	1.50-1.70	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
310, 310B, 310B2, 310C, 310C2, 310D2----------- Galva	0-17	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
	17-33	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	33-60	25-30	1.35-1.45	0.6-2.0	0.20-0.22	6.6-8.4	Moderate-----	0.43		
	60-65	22-30	1.60-1.80	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.43		
354*. Aquolls										
428B------------- Ely	0-28	27-30	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7
	28-46	28-35	1.30-1.40	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
	46-60	20-30	1.40-1.45	0.6-2.0	0.18-0.20	6.6-8.4	Moderate-----	0.43		
433D, 433F, 433G- Storden	0-9	18-30	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
485, 485B-------- Spillville	0-48	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	48-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
505-------------- Sperry	0-11	28-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7
	11-18	18-22	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.28		
	18-50	38-45	1.40-1.45	0.06-0.2	0.14-0.16	5.1-6.5	High---------	0.43		
	50-60	26-34	1.45-1.50	0.2-0.6	0.19-0.21	5.6-7.3	High---------	0.43		
577B2, 577C, 577C2, 577D2---- Everly	0-16	27-30	1.40-1.45	0.6-2.0	0.17-0.19	5.6-7.3	Moderate-----	0.24	5	6
	16-35	25-35	1.45-1.55	0.6-2.0	0.15-0.17	6.1-7.3	Moderate-----	0.32		
	35-60	22-32	1.55-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32		
585B*: Spillville------	0-48	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6
	48-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	Low----------	0.28		
Coland----------	0-8	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	8-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	Pct	g/cc	In/hr	In/in	pH				
633G*:										
Steinauer-------	0-5	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32	5	4L
	5-11	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	Moderate-----	0.32		
	11-60	24-35	1.50-1.80	0.2-0.6	0.14-0.19	7.9-8.4	Moderate-----	0.32		
Steinauer Variant--------	0-12	34-40	1.30-1.60	0.2-0.6	0.15-0.17	6.6-8.4	Moderate-----	0.32	3	4L
	12-47	49-60	1.35-1.50	<0.06	0.14-0.16	7.4-8.4	High---------	0.32		
	47-60	50-65	1.35-1.45	<0.06	0.14-0.16	7.4-8.4	High---------	0.32		
739G*:										
Steinauer-------	0-6	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	Moderate-----	0.32	5	4L
	6-10	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	Moderate-----	0.32		
	10-60	24-35	1.50-1.80	0.2-0.6	0.14-0.19	7.9-8.4	Moderate-----	0.32		
Hawick----------	0-9	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	5	3
	9-20	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-8.4	Low----------	0.10		
	20-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
740C, 740E, 740G- Hawick	0-12	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	5	3
	12-18	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-8.4	Low----------	0.10		
	18-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
810, 810B, 810C2- Galva	0-23	34-39	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	4
	23-60	30-39	1.30-1.35	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.43		
878B, 878C2------ Ocheyedan	0-15	24-27	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	6
	15-35	14-24	1.45-1.60	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
	35-60	12-24	1.45-1.70	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.32		
1609*: Fluvaquents.										
Omadi-----------	0-22	27-30	1.30-1.40	0.6-2.0	0.22-0.24	6.6-8.4	Low----------	0.32	5	5
	22-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43		
1639G*:										
Storden---------	0-9	18-30	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37		
Hawick----------	0-9	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	5	3
	9-20	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-8.4	Low----------	0.10		
	20-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10		
1658C*:										
Terril----------	0-32	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6
	32-60	15-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low----------	0.32		
Coland----------	0-8	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28	5	6
	8-60	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.28		
1785------------ Spillco	0-43	18-26	1.45-1.55	0.6-2.0	0.19-0.21	6.6-8.4	Low----------	0.24	5	6
	43-60	14-28	1.55-1.70	2.0-6.0	0.14-0.19	7.9-8.4	Low----------	0.24		
5010*. Pits										
5040*. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1C3, 1D3, 1E3, 1G-- Ida	B	None	---	---	>6.0	---	---	High	Low	Low.
8B-- Judson	B	None	---	---	>6.0	---	---	High	Moderate	Low.
11B*:										
Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
Judson	B	None	---	---	>6.0	---	---	High	Moderate	Low.
26-- Kennebec	B	Rare	---	---	4.0-6.0	Apparent	Nov-Jul	High	Moderate	Low.
27, 27B, 27C-- Terril	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
28B, 28D-- Dickman	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
31-- Afton	C/D	Occasional	Very brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
33D, 33F, 33G-- Steinauer	B	None	---	---	>6.0	---	---	Moderate	High	Low.
54-- Zook	C/D	Occasional	Brief to long.	Feb-Nov	0-3.0	Apparent	Nov-Jul	High	High	Moderate.
72B, 72C-- Estherville	B	None	---	---	>6.0	---	---	Low	Low	Low.
77B, 77B2, 77C, 77C2, 78B, 78B2, 78C, 78C2-- Sac	B	None	---	---	>6.0	---	---	High	Moderate	Low.
91, 91B-- Primghar	B	None	---	---	3.0-5.0	Apparent	Nov-Jul	High	Moderate	Moderate.
92-- Marcus	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
96-- Turlin	B	Rare	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High	Moderate.
108, 108B-- Wadena	B	None	---	---	>6.0	---	---	Low	Low	Low.
133-- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
135-- Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
189--------------- Omadi	B	Occasional	Brief-----	Apr-Aug	4.0-6.0	---	---	High-----	Low------	Low.
309, 309B--------- Allendorf	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Moderate.
310, 310B, 310B2, 310C, 310C2, 310D2------------ Galva	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
354*. Aquolls										
428B-------------- Ely	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
433D, 433F, 433G-- Storden	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
485--------------- Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
485B-------------- Spillville	B	None---------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
505--------------- Sperry	C/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	High-----	High-----	Moderate.
577B2, 577C, 577C2, 577D2----- Everly	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
585B*: Spillville--------	B	None---------	---	---	3.0-5.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
Coland-----------	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
633G*: Steinauer--------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Steinauer Variant	D	None---------	---	---	1.0-3.0	Perched	Nov-Jul	High-----	High-----	Moderate.
739G*: Steinauer--------	B	None---------	---	---	>6.0	---	---	Moderate	High-----	Low.
Hawick-----------	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
740C, 740E, 740G-- Hawick	A	None---------	---	---	>6.0	---	---	Low------	Low------	Low.
810, 810B, 810C2-- Galva	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
878B, 878C2------- Ocheyedan	B	None---------	---	---	>6.0	---	---	Moderate	Low------	Low.
1609*: Fluvaquents.										
Omadi------------	B	Occasional	Brief-----	Apr-Aug	>6.0	---	---	High-----	Low------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1639G*:										
Storden	B	None	---	---	>6.0	---	---	Moderate	Low	Low.
Hawick	A	None	---	---	>6.0	---	---	Low	Low	Low.
1658C*:										
Terril	B	None	---	---	>6.0	---	---	Moderate	Moderate	Low.
Coland	B/D	Frequent	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
1785 Spillco	B	Frequent	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	High	Moderate	Low.
5010*. Pits										
5040*. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Afton	Fine-silty, mixed, mesic Cumulic Haplaquolls
Allendorf	Fine-silty over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Aquolls	Fine, montmorillonitic, mesic Typic Haplaquolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Everly	Fine-loamy, mixed, mesic Typic Hapludolls
Fluvaquents	Loamy, mixed, mesic Fluvaquents
Galva	Fine-silty, mixed, mesic Typic Hapludolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
Ida	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Marcus	Fine-silty, mixed, mesic Typic Haplaquolls
Ocheyedan	Fine-loamy, mixed, mesic Typic Hapludolls
Omadi	Fine-silty, mixed, mesic Fluventic Hapludolls
Orthents	Loamy, mixed, mesic Udorthents
Primghar	Fine-silty, mixed, mesic Aquic Hapludolls
Sac	Fine-silty, mixed, mesic Typic Hapludolls
*Sperry	Fine, montmorillonitic, mesic Typic Argialbolls
Spillco	Fine-loamy, mixed, mesic Cumulic Hapludolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Steinauer Variant	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Turlin	Fine-loamy, mixed, mesic Cumulic Hapludolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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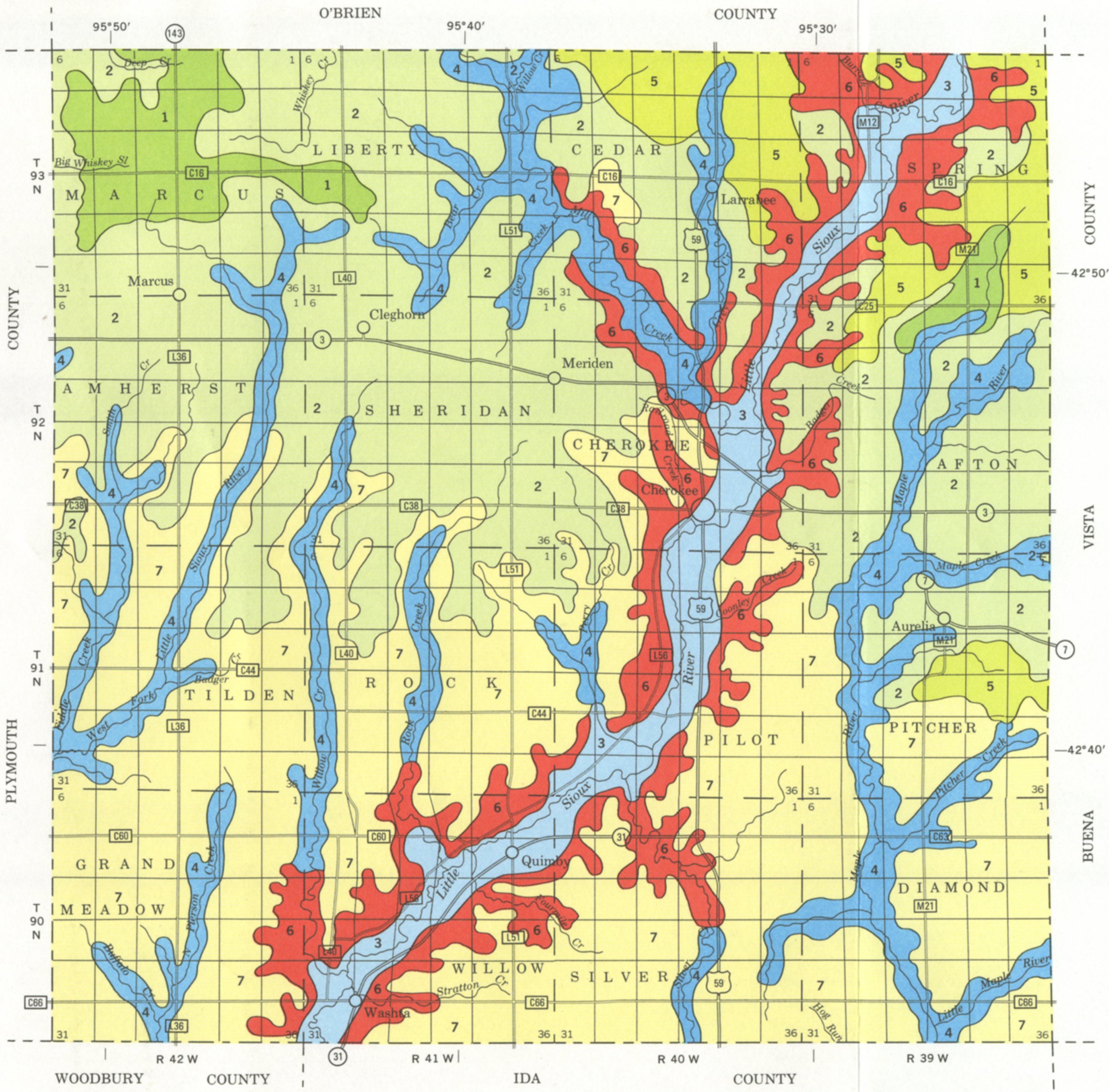
Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



LEGEND*

1	MARCUS-PRIMGHAR-GALVA association: Nearly level and gently sloping, poorly drained, somewhat poorly drained, and well drained, silty soils formed in loess; on uplands
2	GALVA-PRIMGHAR association: Nearly level and gently sloping, well drained and somewhat poorly drained, silty soils formed in loess; on uplands
3	OMADI-COLO-ALLENDORF association: Nearly level and gently sloping, moderately well drained, poorly drained, and well drained, silty soils formed in alluvium and loess; on bottom land and stream terraces
4	COLO-GALVA association: Nearly level to moderately sloping, poorly drained and well drained, silty soils formed in alluvium and loess; on bottom land and stream terraces
5	SAC-GALVA-PRIMGHAR association: Gently sloping and moderately sloping, well drained and somewhat poorly drained, silty soils formed in loess or in loess and the underlying glacial till; on uplands
6	STEINAUER-STORDEN association: Strongly sloping to very steep, well drained, loamy soils formed in glacial till; on uplands
7	GALVA association: Gently sloping to strongly sloping, well drained, silty soils formed in loess; on uplands

*Texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

COMPILED 1987

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DIVISION OF SOIL CONSERVATION
IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP

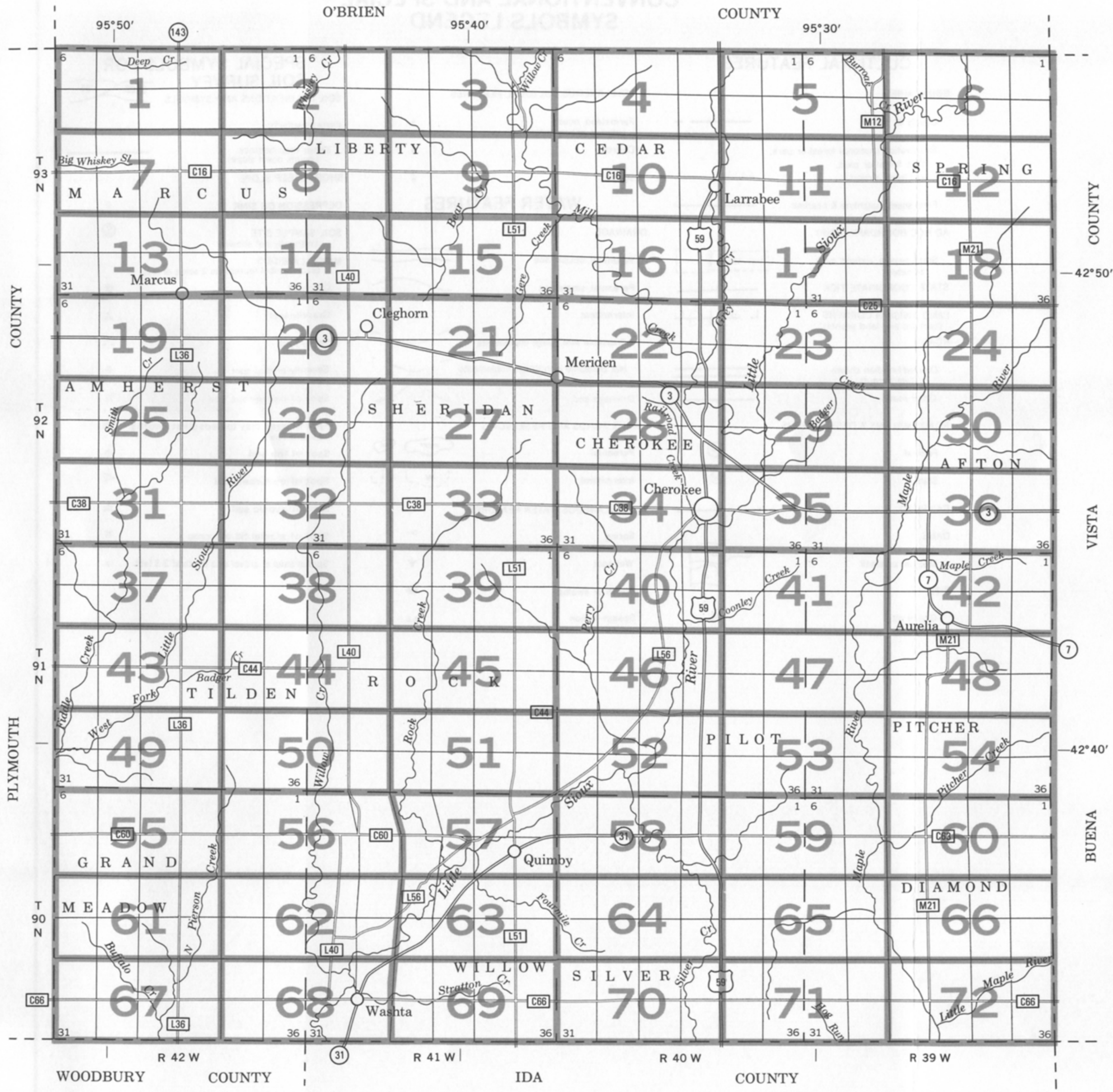
GENERAL SOIL MAP

CHEROKEE COUNTY, IOWA

Scale 1:190,080

1 0 1 2 3 Mi

1 0 3 6 Km



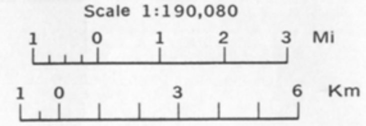
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS

CHEROKEE COUNTY, IOWA

Scale 1:190,080



SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is moderately eroded and 3 that it is severely eroded.

SYMBOL	NAME
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded
1D3	Ida silt loam, 9 to 14 percent slopes, severely eroded
1E3	Ida silt loam, 14 to 20 percent slopes, severely eroded
1G	Ida silt loam, 20 to 40 percent slopes
8B	Judson silty clay loam, 2 to 5 percent slopes
11B	Colo-Judson silty clay loams, 0 to 5 percent slopes
26	Kennebec silty clay loam, 0 to 2 percent slopes
27	Terril loam, 0 to 2 percent slopes
27B	Terril loam, 2 to 5 percent slopes
27C	Terril loam, 5 to 9 percent slopes
28B	Dickman sandy loam, 2 to 5 percent slopes
28D	Dickman sandy loam, 5 to 12 percent slopes
31	Afton silty clay loam, 0 to 2 percent slopes
33D	Steinauer clay loam, 9 to 14 percent slopes
33F	Steinauer clay loam, 14 to 25 percent slopes
33G	Steinauer clay loam, 25 to 40 percent slopes
54	Zook silty clay loam, 0 to 2 percent slopes
72B	Estherville loam, 2 to 5 percent slopes
72C	Estherville loam, 5 to 9 percent slopes
77B	Sac silty clay loam, loam substratum, 2 to 5 percent slopes
77B2	Sac silty clay loam, loam substratum, 2 to 5 percent slopes, moderately eroded
77C	Sac silty clay loam, loam substratum, 5 to 9 percent slopes
77C2	Sac silty clay loam, loam substratum, 5 to 9 percent slopes, moderately eroded
78B	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes
78B2	Sac silty clay loam, clay loam substratum, 2 to 5 percent slopes, moderately eroded
78C	Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes
78C2	Sac silty clay loam, clay loam substratum, 5 to 9 percent slopes, moderately eroded
91	Primghar silty clay loam, 0 to 2 percent slopes
91B	Primghar silty clay loam, 1 to 4 percent slopes
92	Marcus silty clay loam, 0 to 2 percent slopes
95	Turlin loam, 0 to 2 percent slopes
108	Wadena loam, 24 to 32 inches to sand and gravel, 0 to 2 percent slopes
108B	Wadena loam, 24 to 32 inches to sand and gravel, 2 to 5 percent slopes
133	Colo silty clay loam, 0 to 2 percent slopes
135	Coland clay loam, 0 to 2 percent slopes
189	Omadi silty clay loam, 0 to 2 percent slopes
309	Allendorf silty clay loam, 0 to 2 percent slopes
309B	Allendorf silty clay loam, 2 to 5 percent slopes
310	Galva silty clay loam, 0 to 2 percent slopes
310B	Galva silty clay loam, 2 to 5 percent slopes
310B2	Galva silty clay loam, 2 to 5 percent slopes, moderately eroded
310C	Galva silty clay loam, 5 to 9 percent slopes
310C2	Galva silty clay loam, 5 to 9 percent slopes, moderately eroded
310D2	Galva silty clay loam, 9 to 14 percent slopes, moderately eroded
354	Aquolls, ponded
428B	Ely silty clay loam, 1 to 4 percent slopes
433D	Storden loam, 9 to 14 percent slopes
433F	Storden loam, 14 to 25 percent slopes
433G	Storden loam, 25 to 50 percent slopes
485	Spillville loam, 0 to 2 percent slopes
485B	Spillville loam, 1 to 4 percent slopes
505	Sperry silty clay loam, 0 to 1 percent slopes
577B2	Everly clay loam, 2 to 5 percent slopes, moderately eroded
577C	Everly clay loam, 5 to 9 percent slopes
577C2	Everly clay loam, 5 to 9 percent slopes, moderately eroded
577D2	Everly clay loam, 9 to 14 percent slopes, moderately eroded
585B	Spillville-Coland complex, 1 to 5 percent slopes
633G	Steinauer-Steinauer Variant clay loams, 20 to 50 percent slopes
739G	Steinauer-Hawick complex, 25 to 40 percent slopes
740C	Hawick sandy loam, 2 to 9 percent slopes
740E	Hawick sandy loam, 9 to 18 percent slopes
740G	Hawick sandy loam, 18 to 35 percent slopes
810	Galva silty clay loam, benches, 0 to 2 percent slopes
810B	Galva silty clay loam, benches, 2 to 5 percent slopes
810C2	Galva silty clay loam, benches, 5 to 9 percent slopes, moderately eroded
878B	Ocheyedan loam, 2 to 5 percent slopes
878C2	Ocheyedan loam, 5 to 9 percent slopes, moderately eroded
1609	Fluvaquents-Omadi complex, channeled, 0 to 2 percent slopes
1639G	Storden-Hawick complex, 25 to 50 percent slopes
1658C	Terril-Coland complex, channeled, 2 to 9 percent slopes
1785	Spillco loam, channeled, 0 to 2 percent slopes
5010	Pits, sand and gravel
5040	Orthents, loamy

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- County or parish
- Reservation (national forest or park, state forest or park, and large airport)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, cemetery — Davis Airstrip

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads

ROAD EMBLEMS & DESIGNATIONS

- Federal — 410
- State — 52

RAILROAD

DAMS

- Medium or small — water; w

PITS

- Gravel pit

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Crossable with tillage implements
- Not crossable with tillage implements
- Drainage end

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Spring
- Wet spot
- Marsh or swamp
- Sewage lagoon — S.L.

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 310B 91

ESCARPMENTS

- Other than bedrock (points down slope)

SHORT STEEP SLOPE

DEPRESSION OR SINK

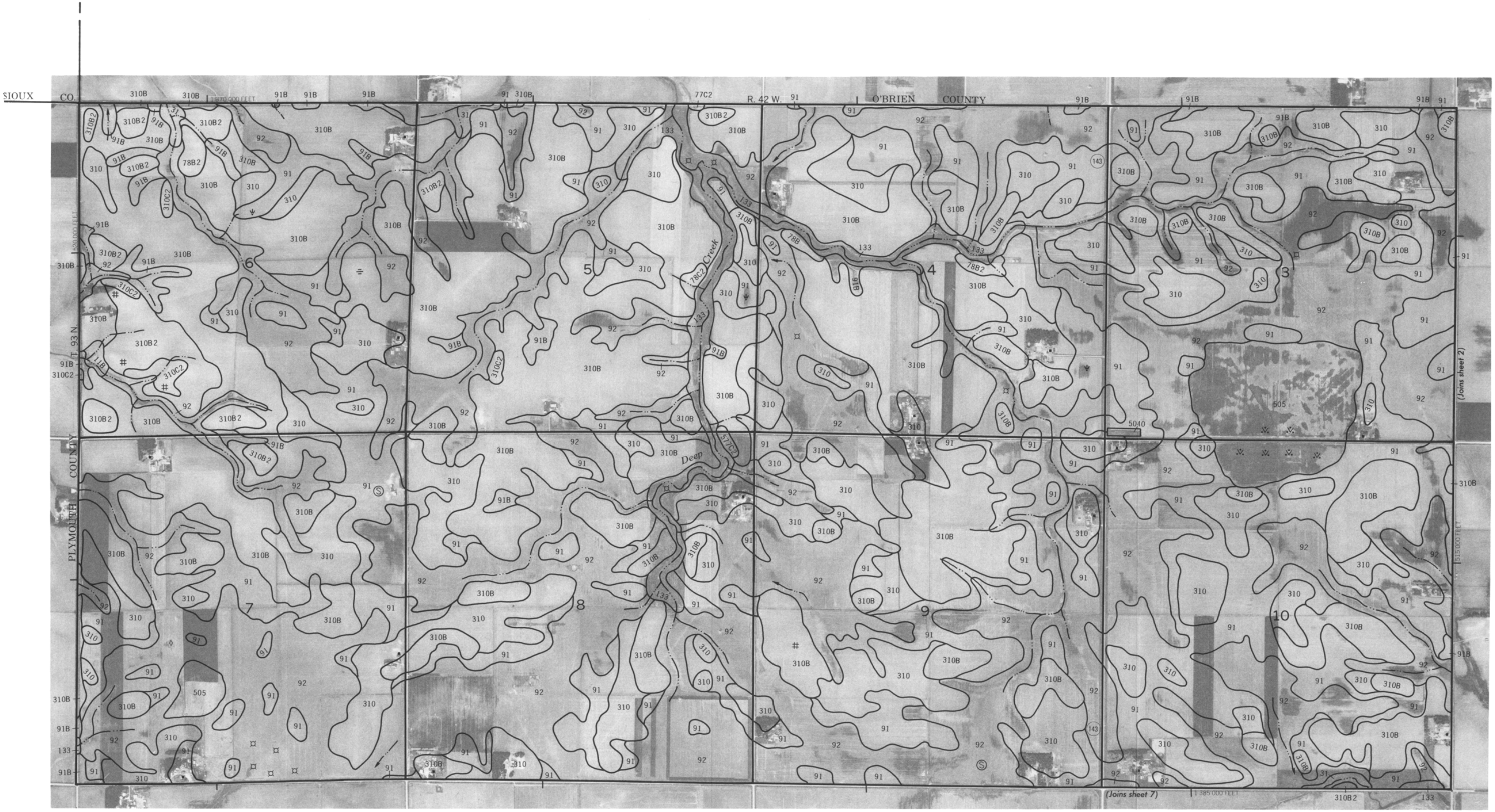
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS (each symbol represents 2 acres or less)

- Clay spot
- Gravelly spot
- Sandy spot
- Severely eroded spot
- Spot of calcareous soil
- Spot of gray clay (paleosol) at depths of 2-4 feet
- Spot of Ida soil
- Spot of disturbed soil
- Spot of gypsic soil
- Spot of glacial till out crop
- Spot of sand or gravel at a depth of 2-3 feet

1

N


SIOUX CO.
O'BRIEN COUNTY
PLYMOUTH COUNTY
R. 42 W.
T. 93 N.
Deep Creek
(Joins sheet 2)
(Joins sheet 7)
1 385 000 FEET
1
2
3
4
5
6
7
8
9
10

2

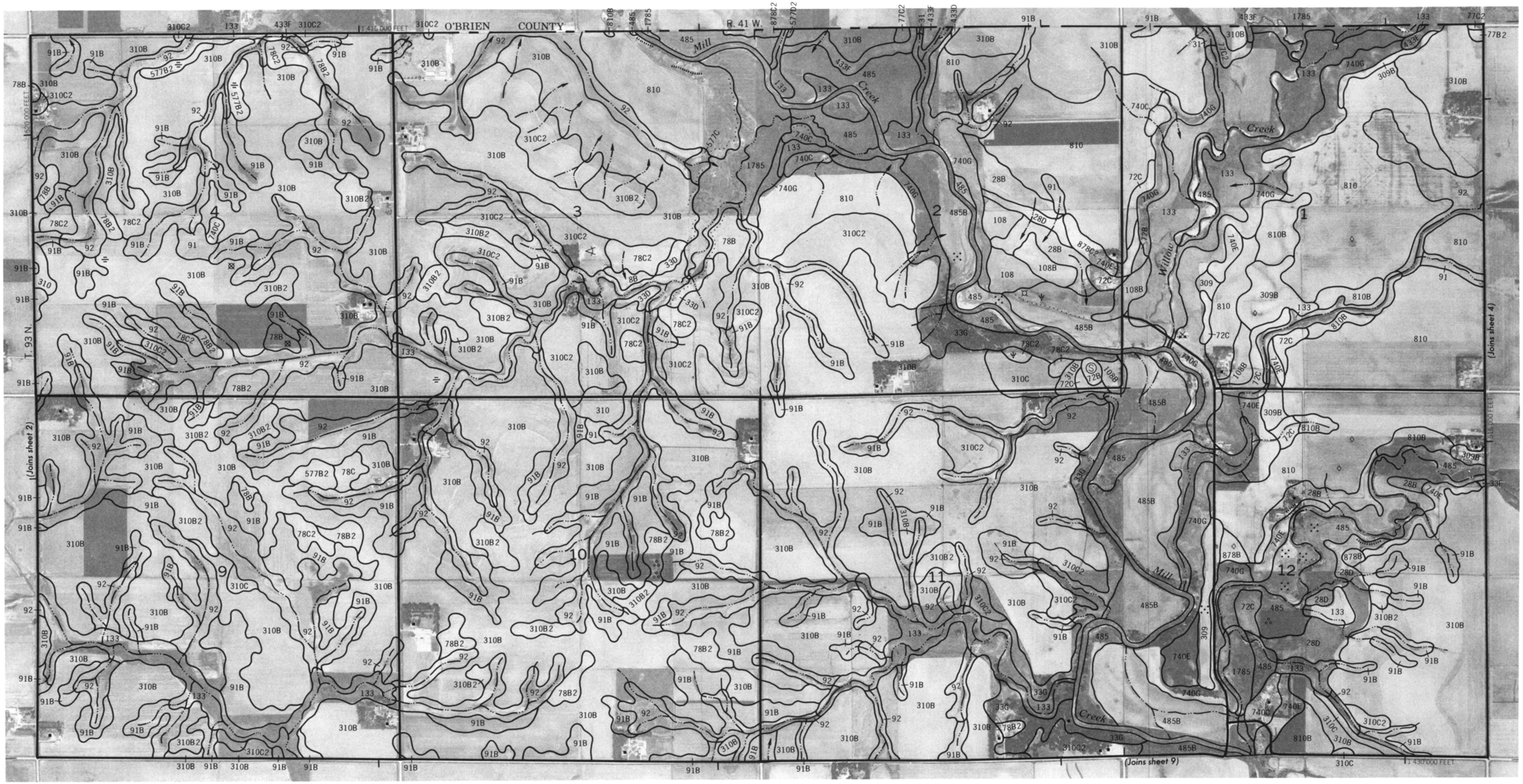
N


O'BRIEN COUNTY
R. 42 W.
R. 41 W.
T. 93 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)
Whiskey
Creek
1 410 000 FEET
1 390 000 FEET
1
2
5
6
7
8
11
12

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 3

3

N



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 4

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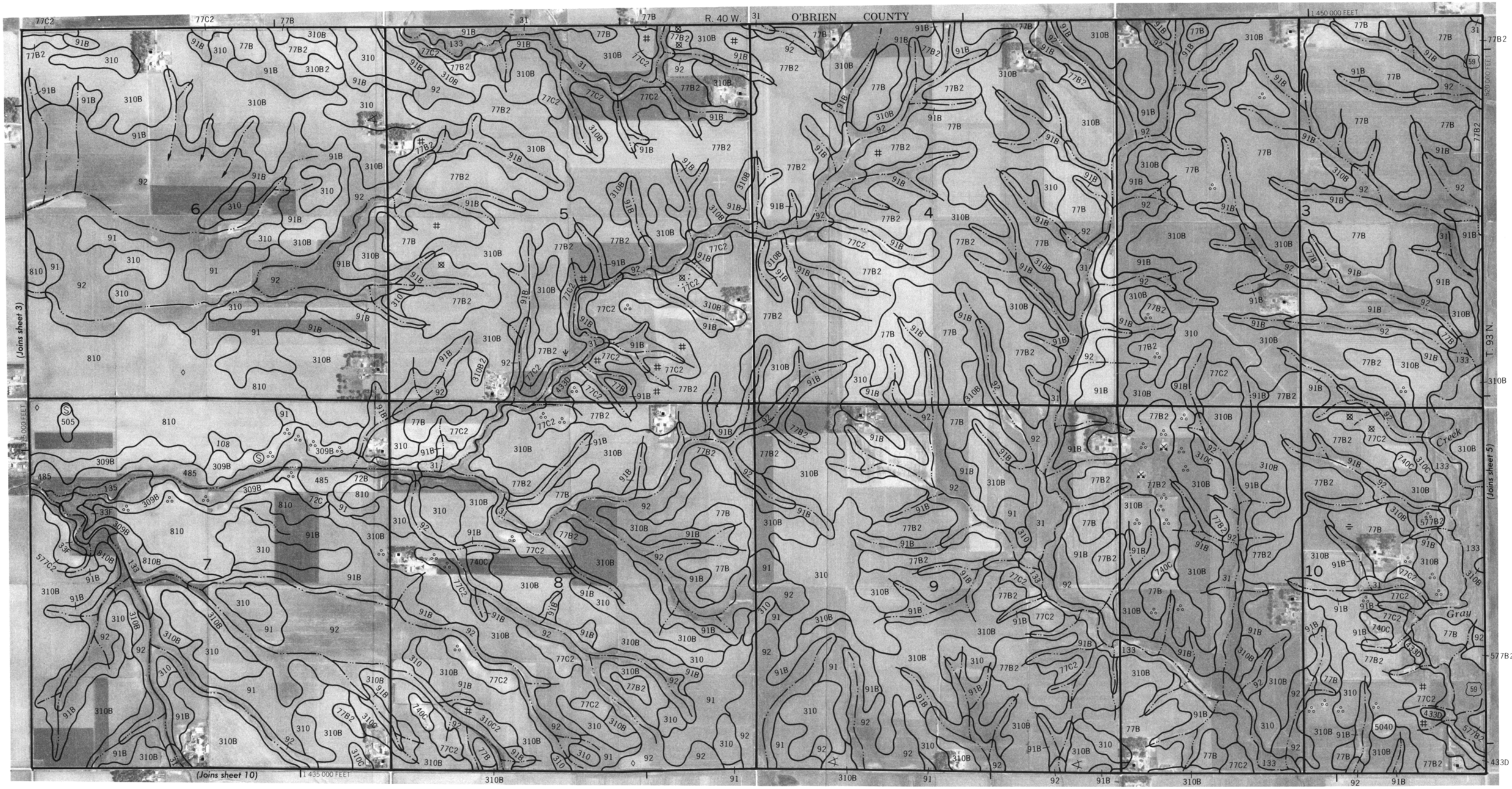

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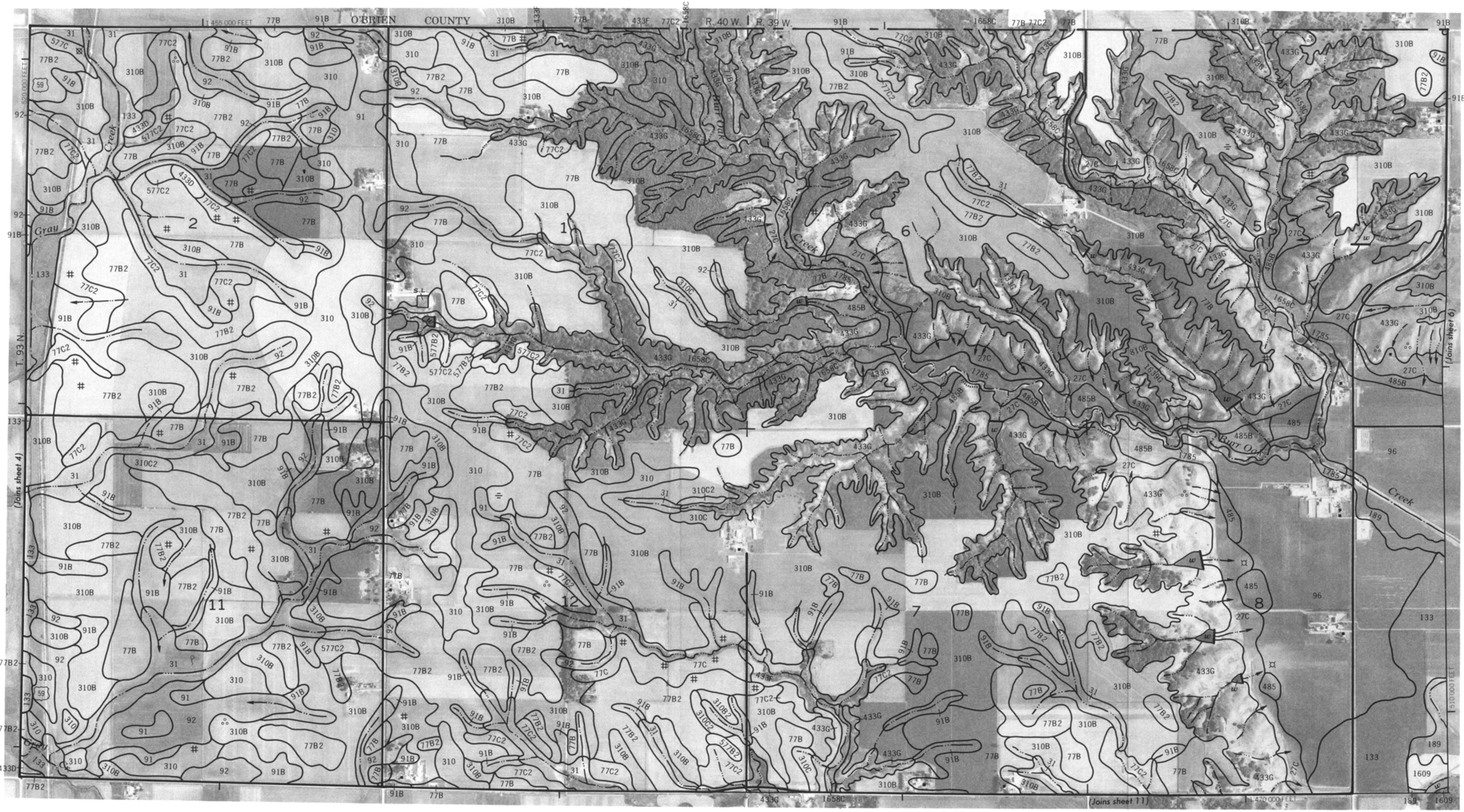
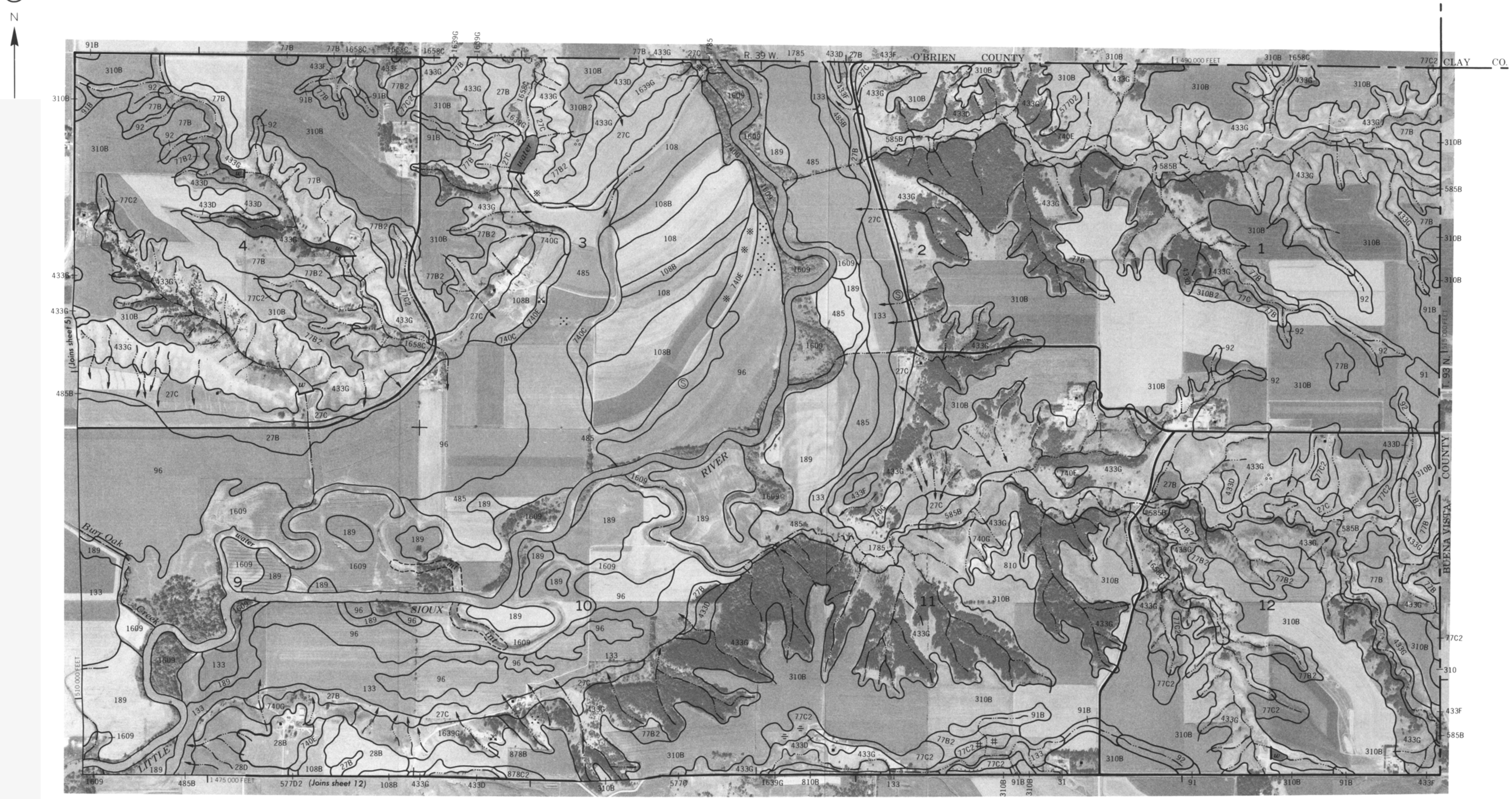
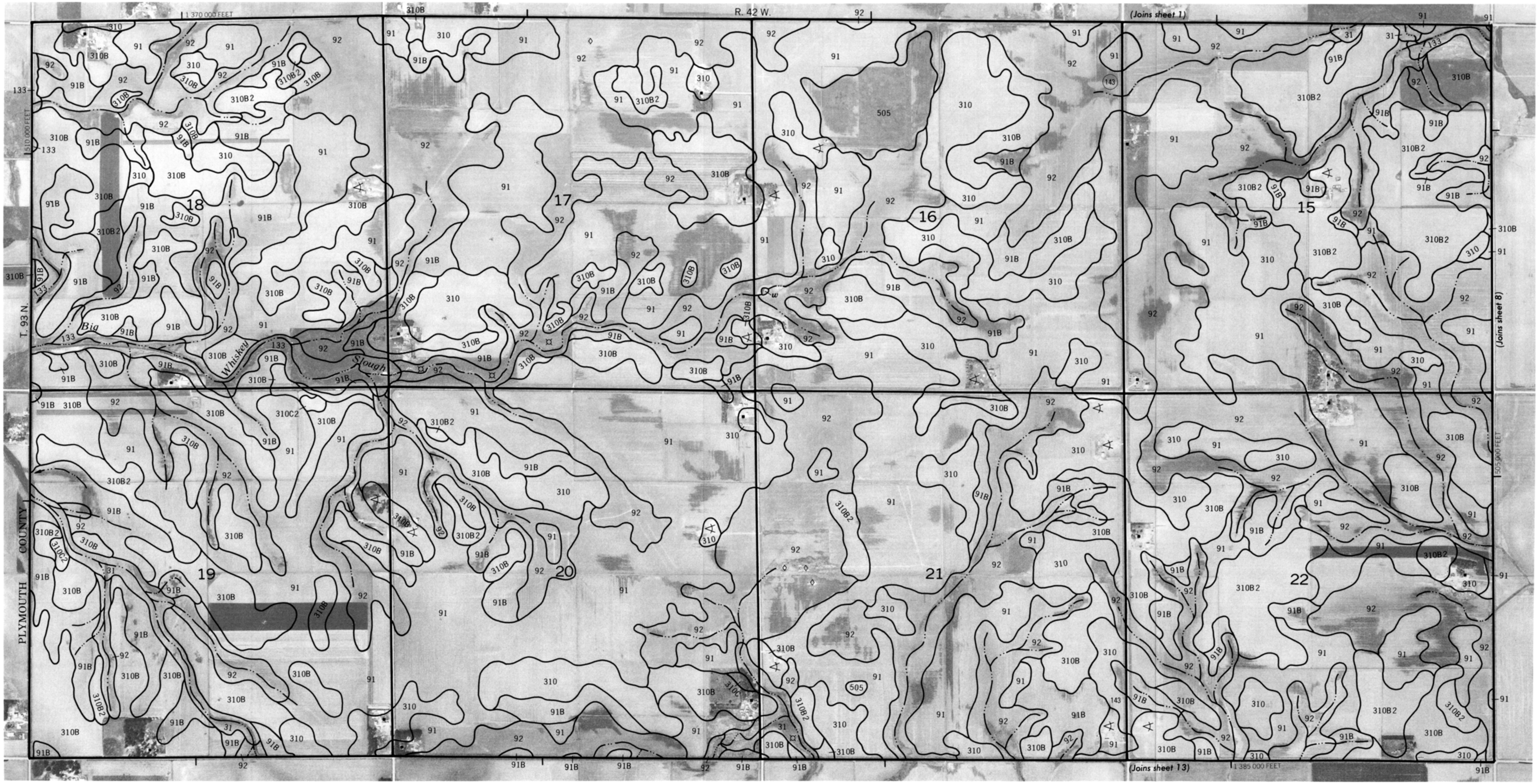

O'BRIEN COUNTY
1 455 000 FEET
R. 40 W.
R. 39 W.
T. 93 N.
520 000 FEET
510 000 FEET
1 470 000 FEET
Gray Creek
Burr Oak Creek
Creek
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)

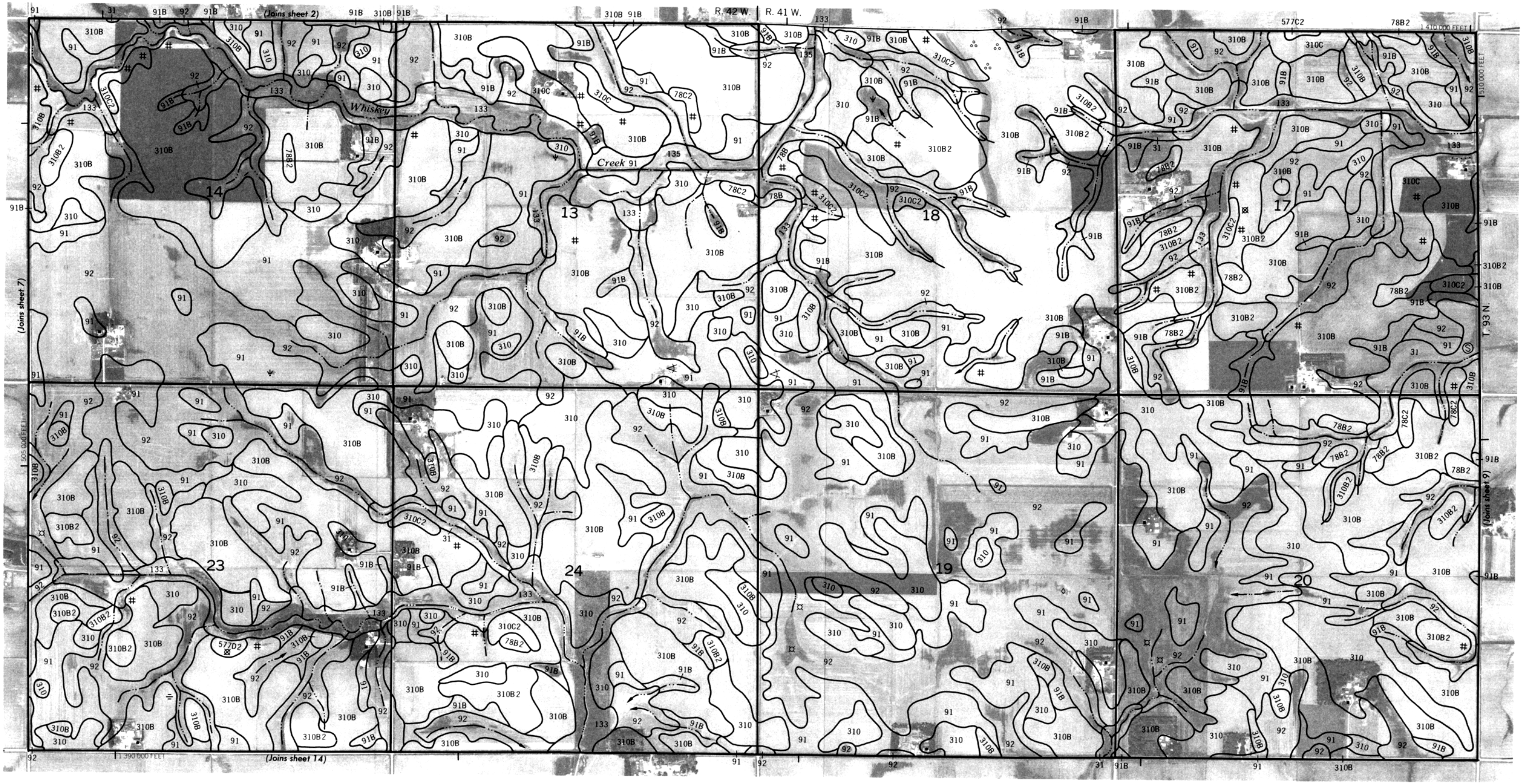
SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 6




1 370 000 FEET
R. 42 W.
(Joins sheet 1)
(Joins sheet 8)
(Joins sheet 13)
1 385 000 FEET
510 000 FEET
505 000 FEET
T. 93 N.
PLYMOUTH COUNTY
Big Whiskey Slough
18
17
16
15
19
20
21
22

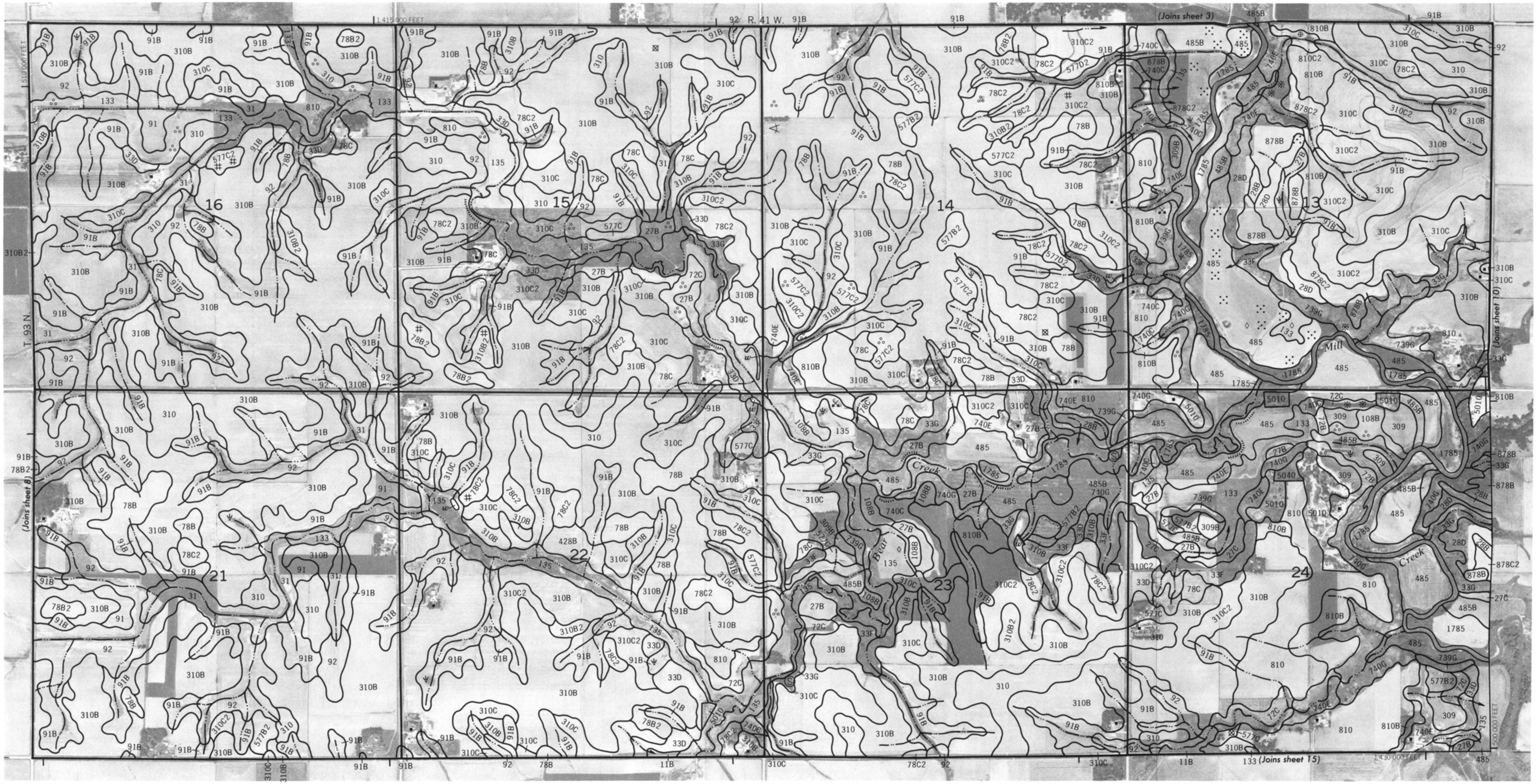
N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 8



9

N

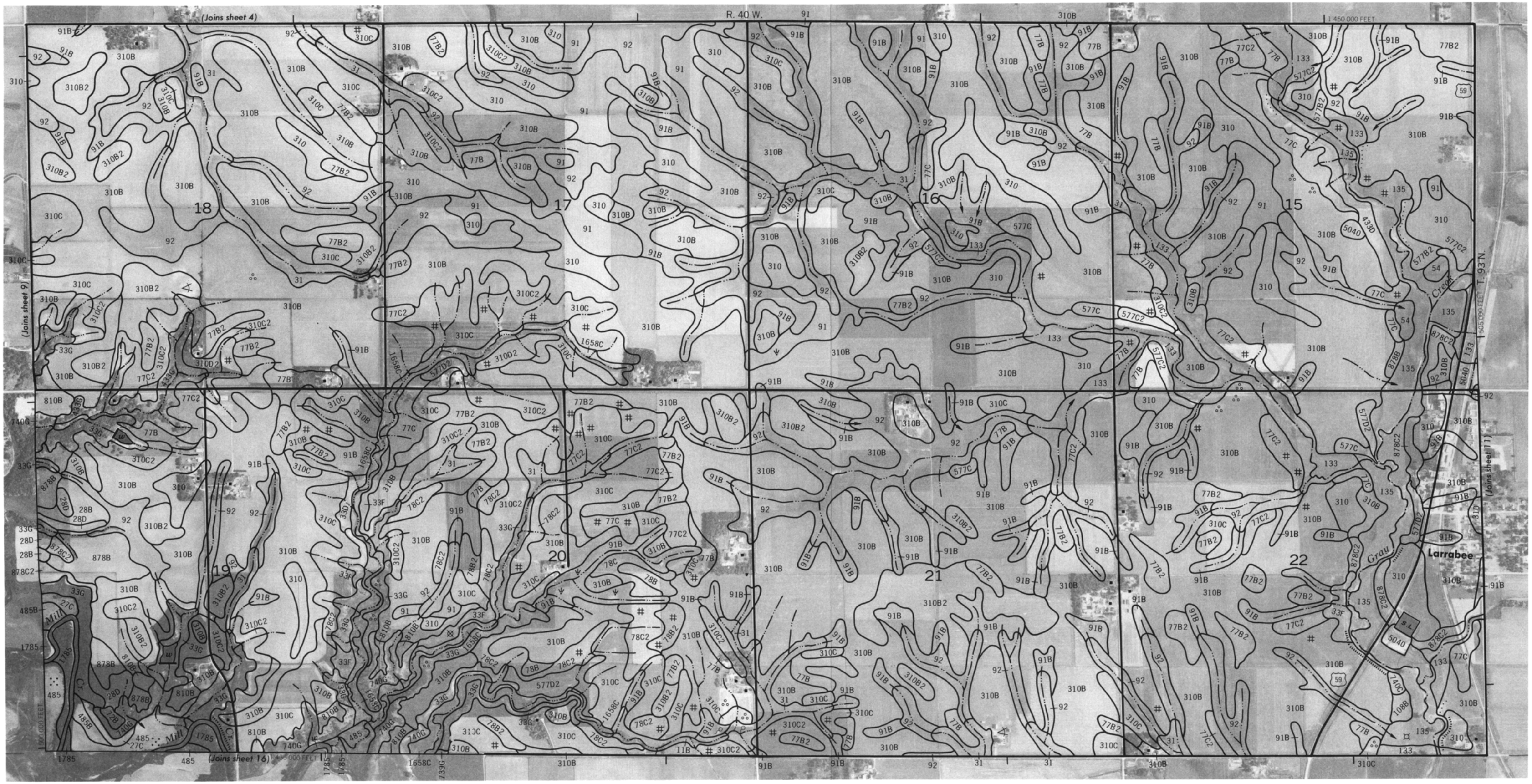


1 415 000 FEET
R. 41 W.
(Joins sheet 3)
510 000 FEET
T. 93 N.
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 15)
1 430 000 FEET
500 000 FEET
16
15
14
13
21
22
23
24
Bear Creek
Mill Creek
Creek

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 10

10

N



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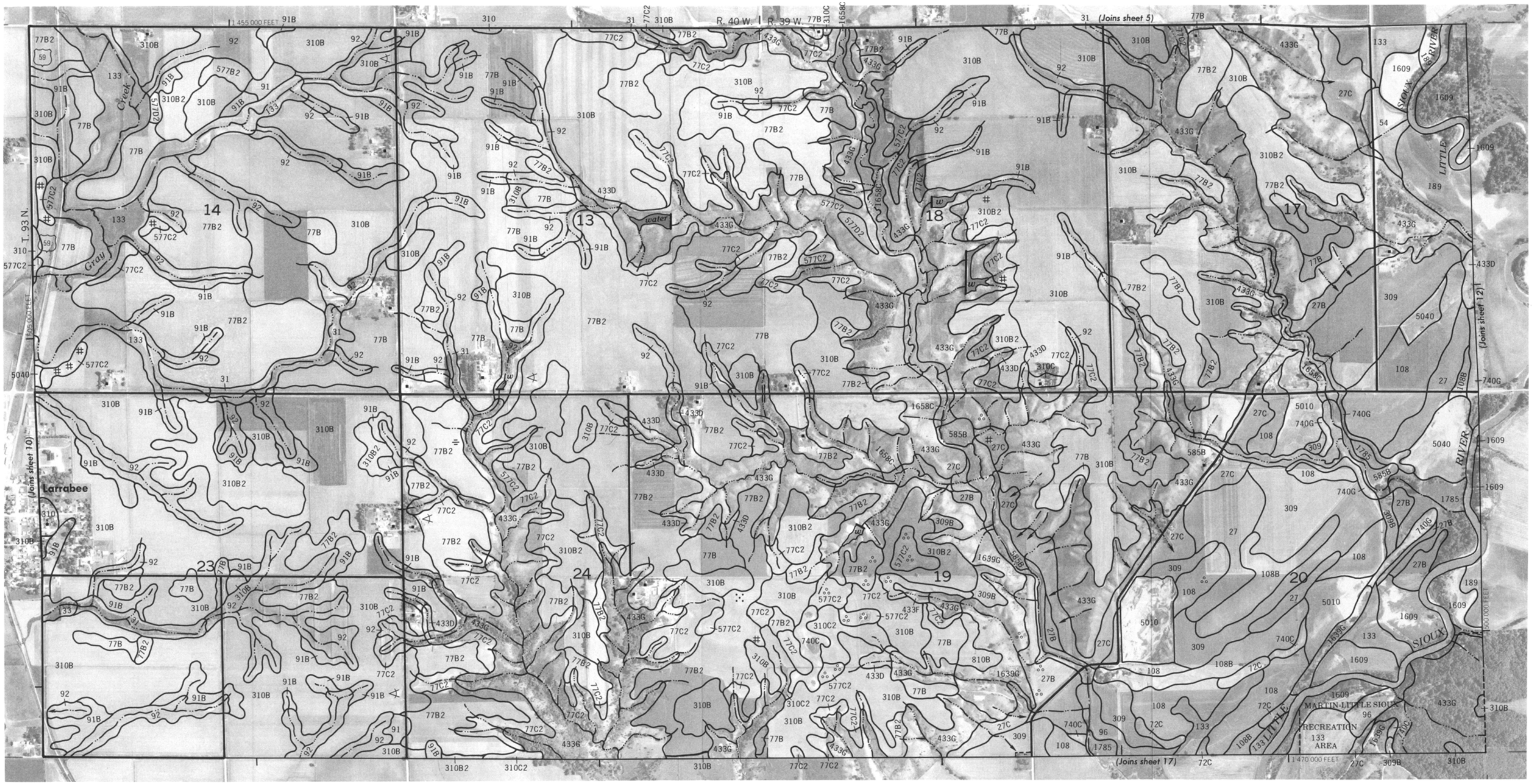
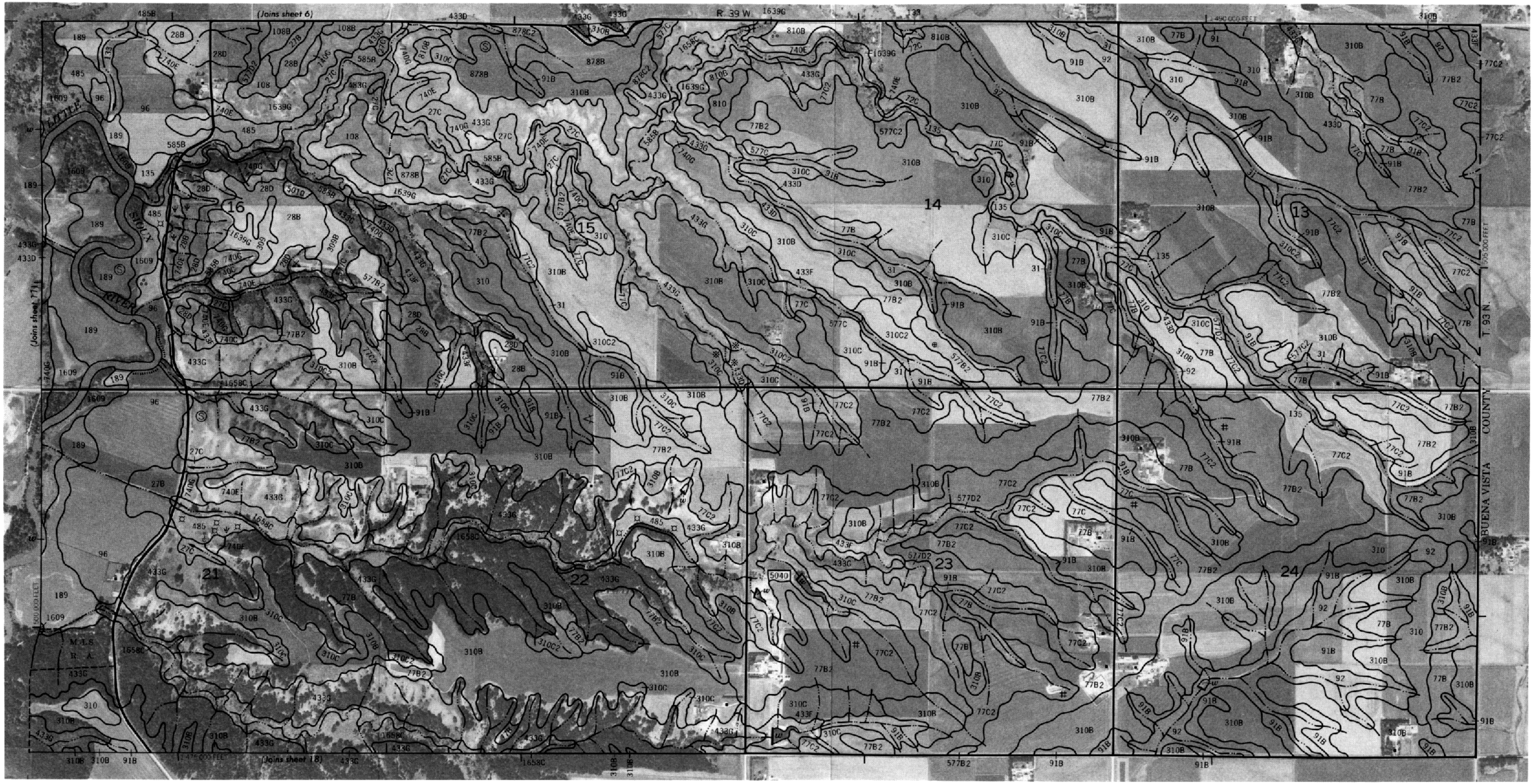


(Joins sheet 5)
(Joins sheet 17)
(Joins sheet 12)
(Joins sheet 10)
R. 40 W.
R. 39 W.
T. 93 N.
1 455 000 FEET
1 470 000 FEET
500 000 FEET
Larrabee
Gray Creek
LITTLE SIOUX RIVER
MARTIN-LITTLE SIOUX RECREATION AREA
water

(12)

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 12

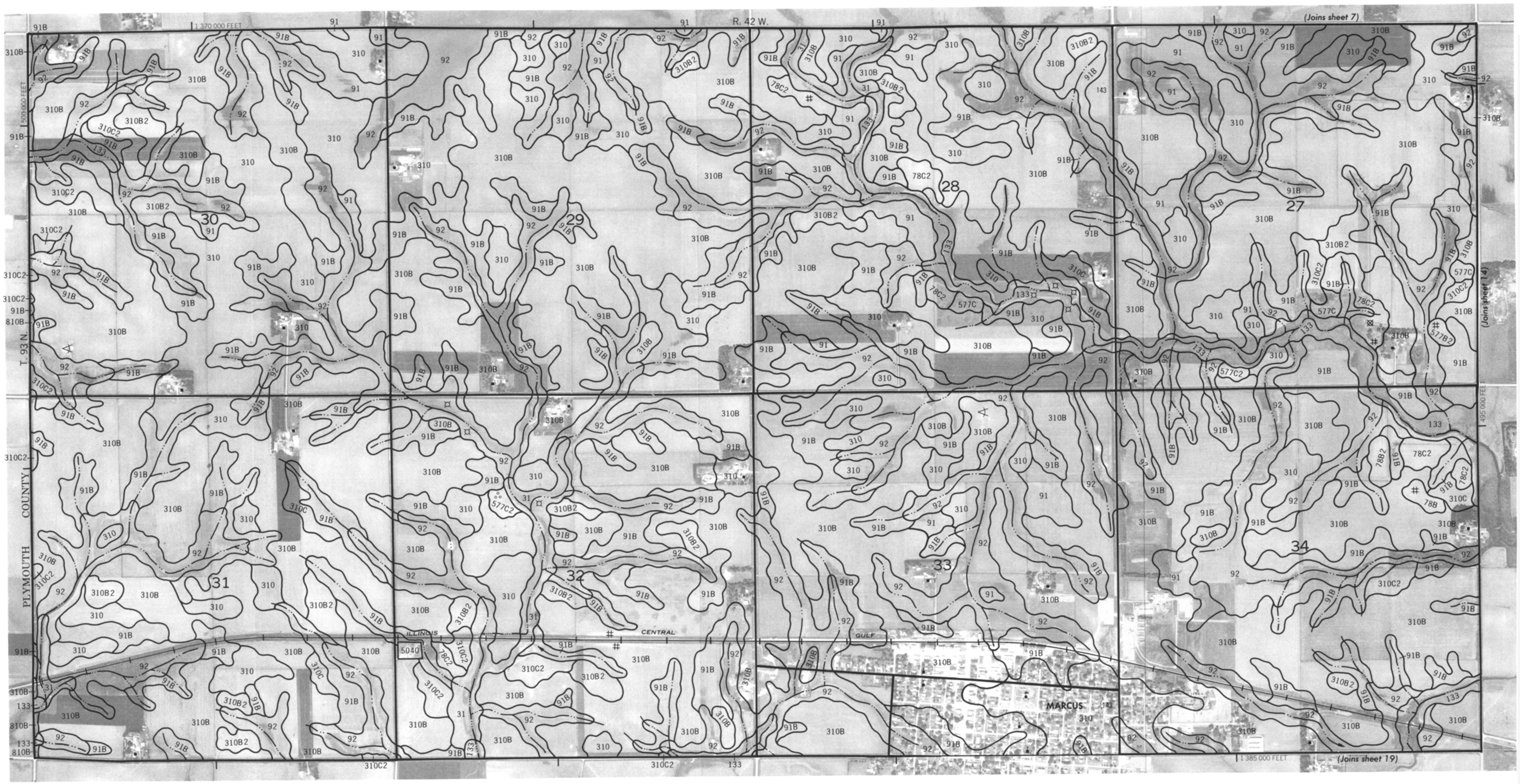
N



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 13

13

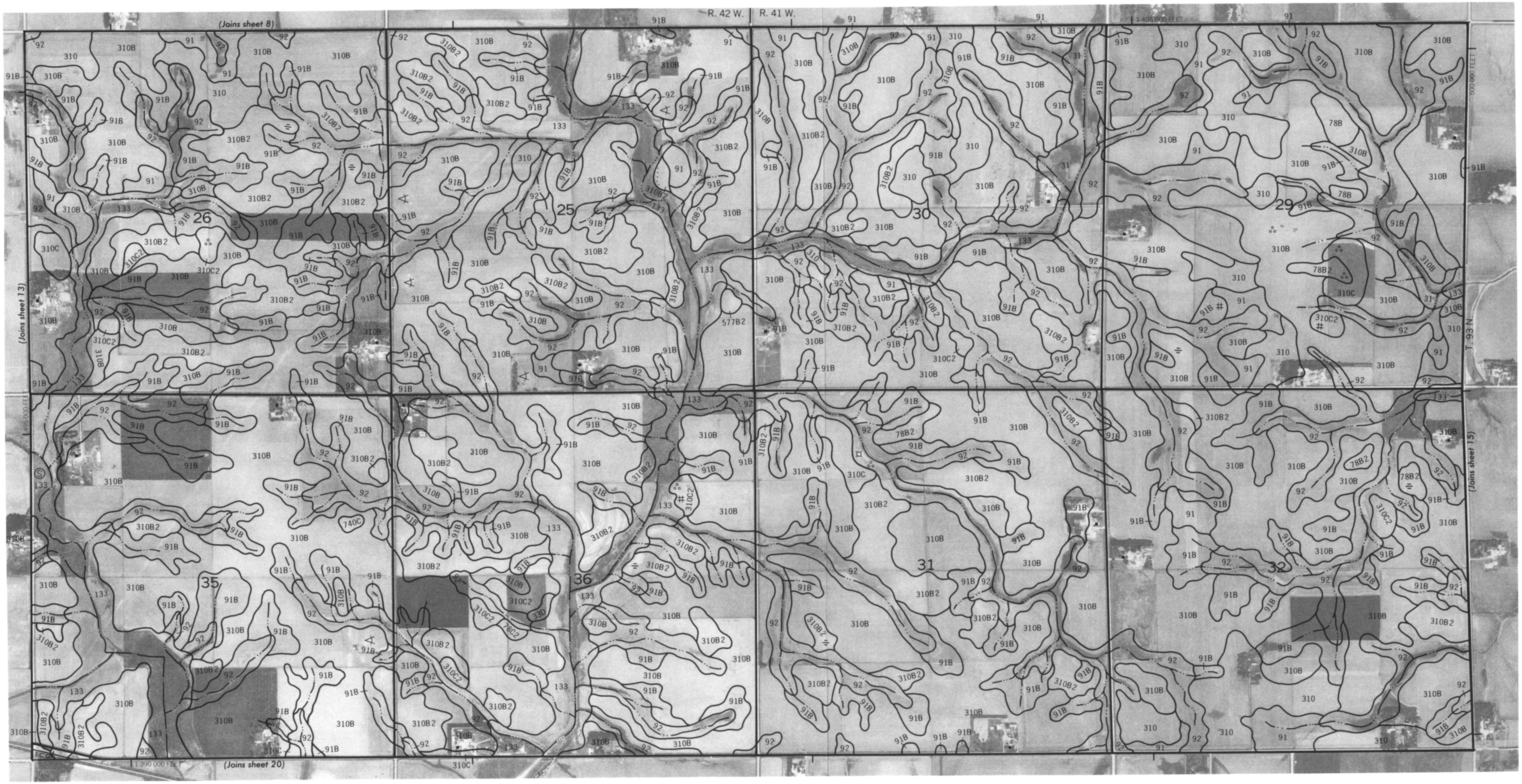
N



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 14

14

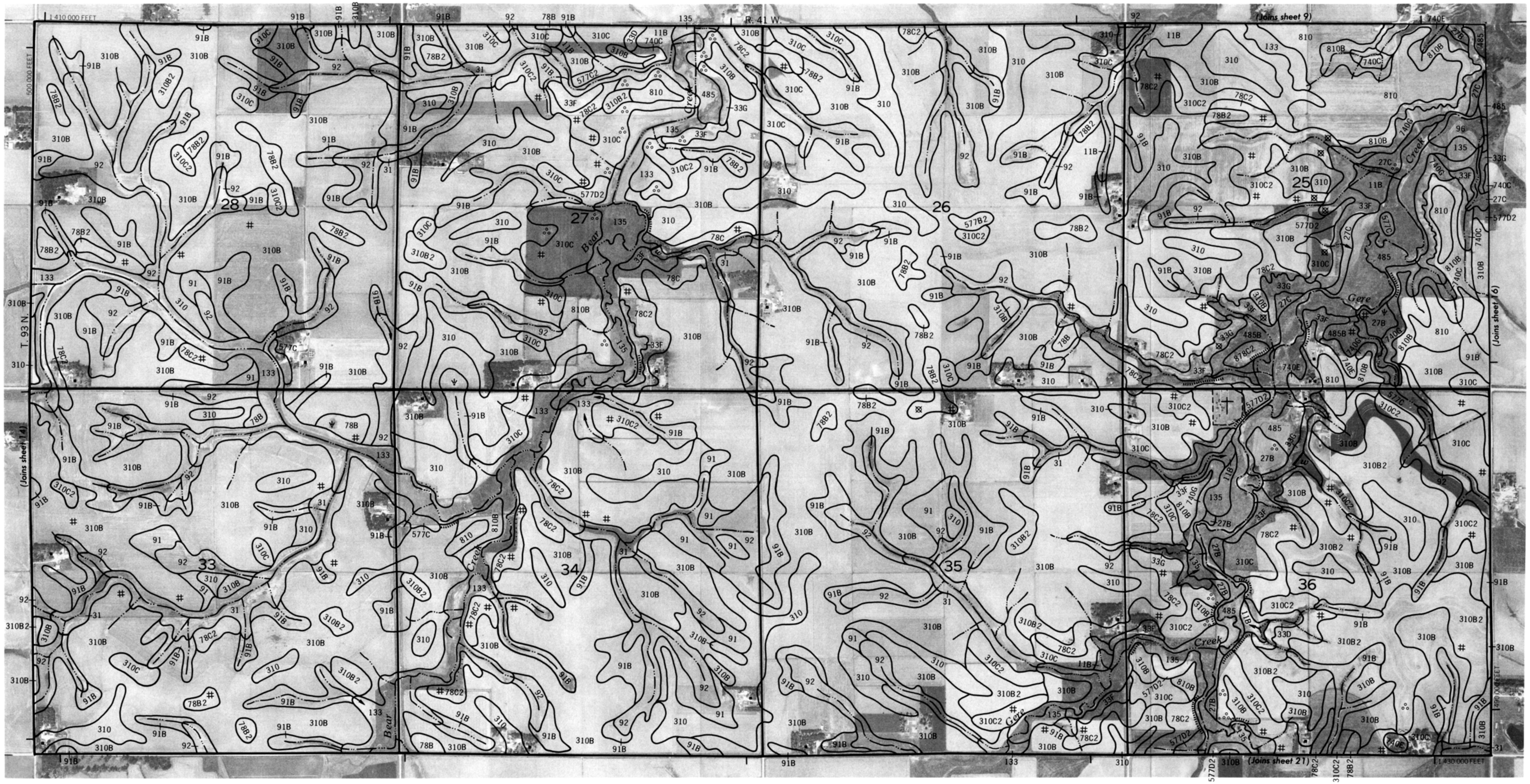
N



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 15

15

N



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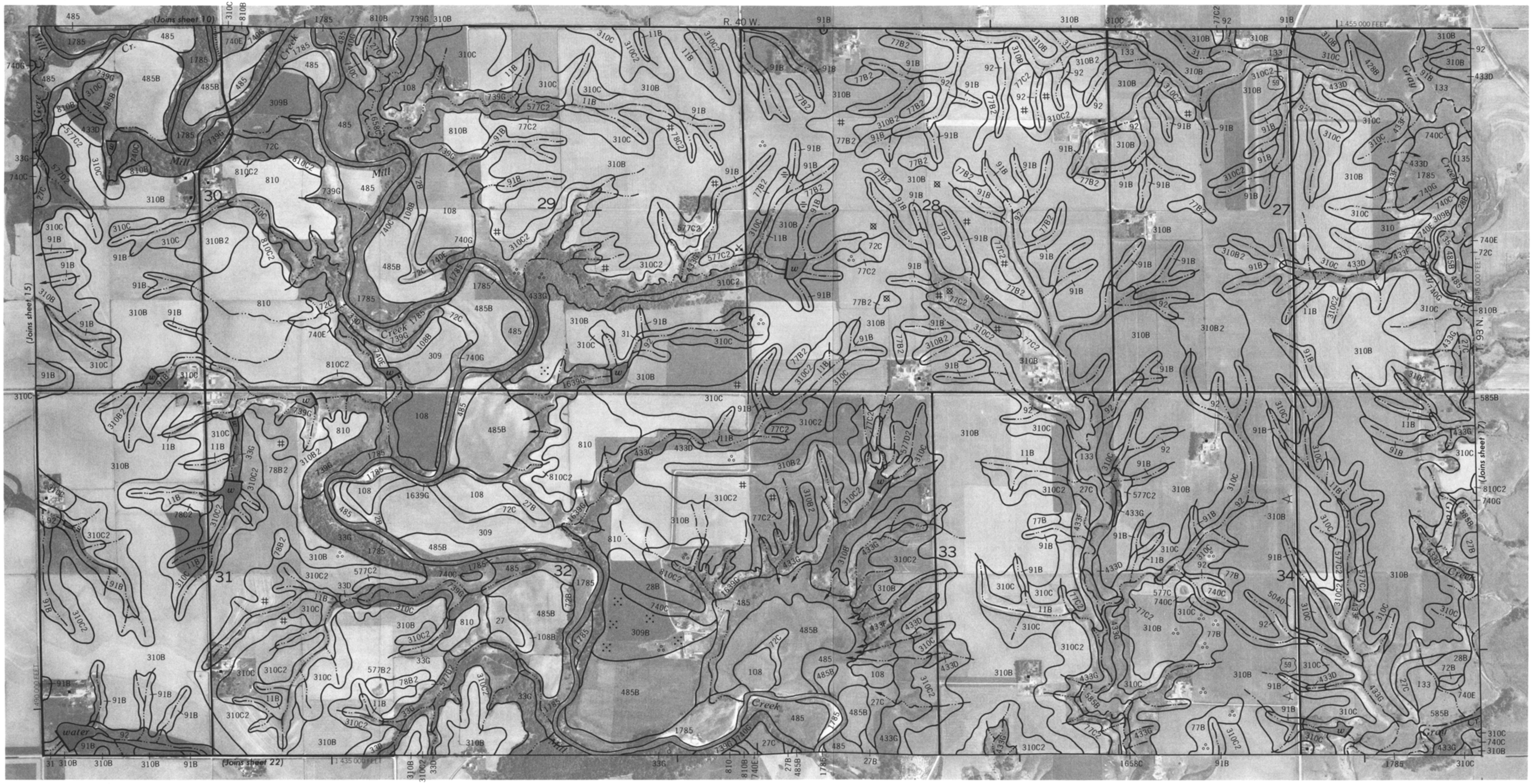
SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 16



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 17

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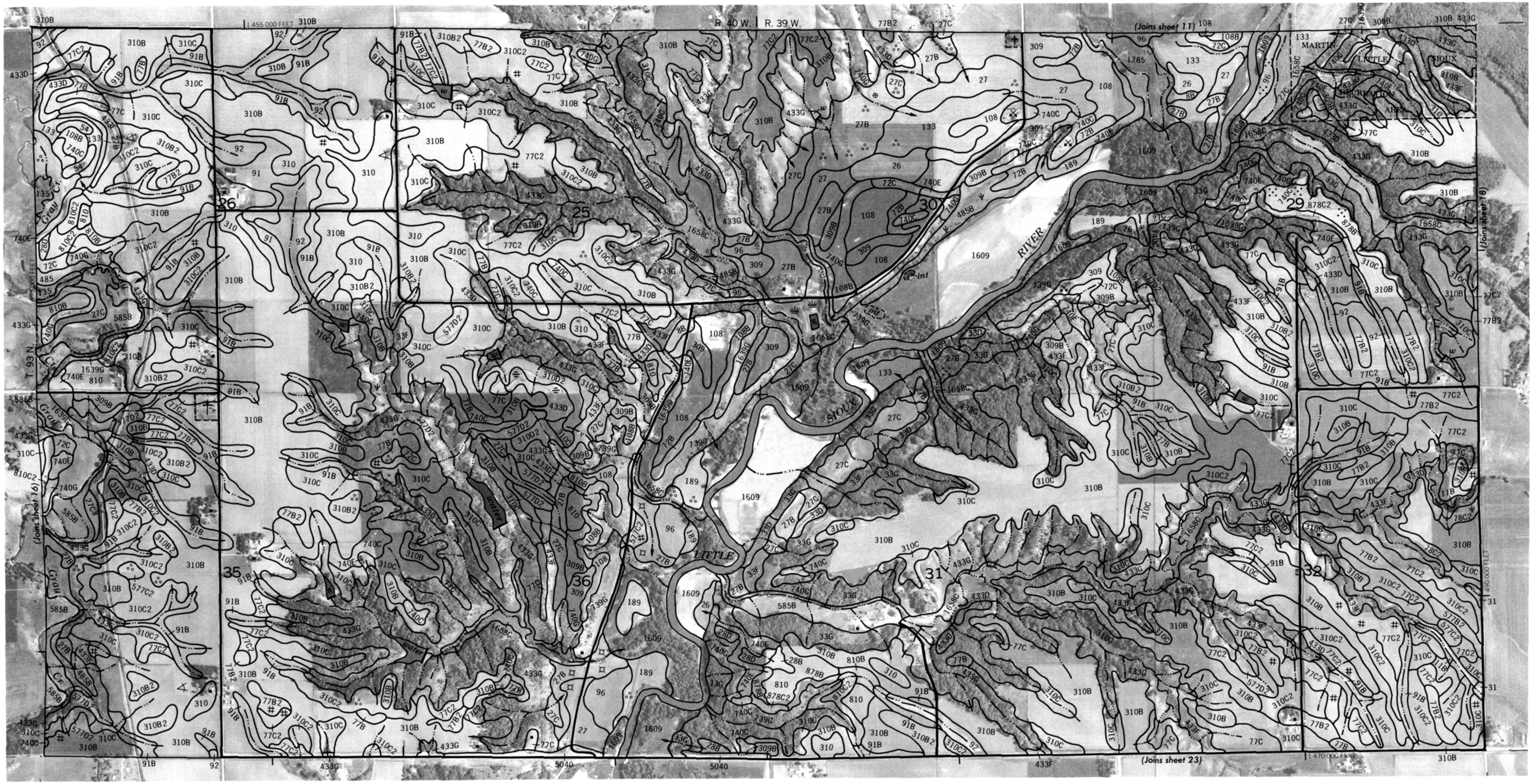
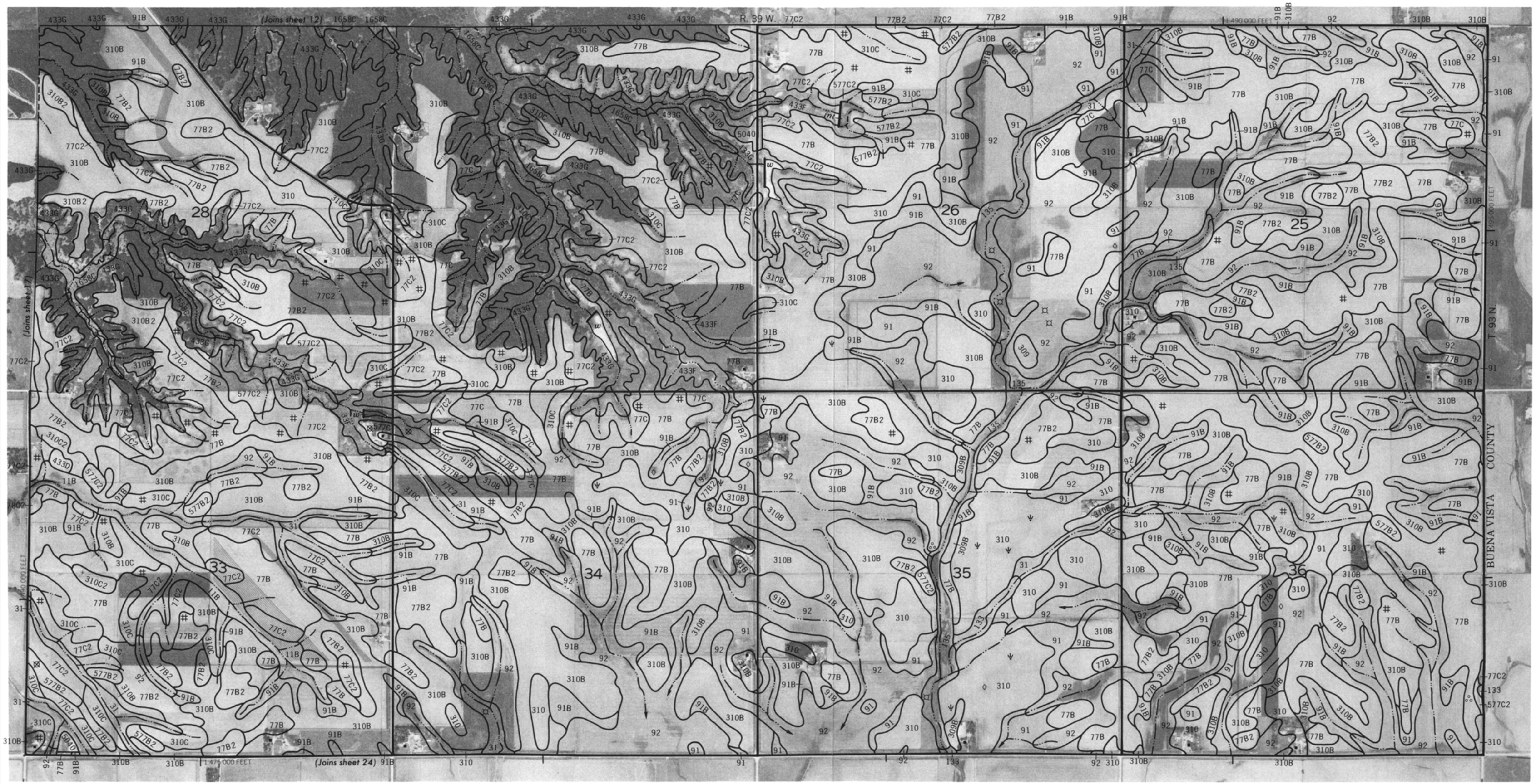


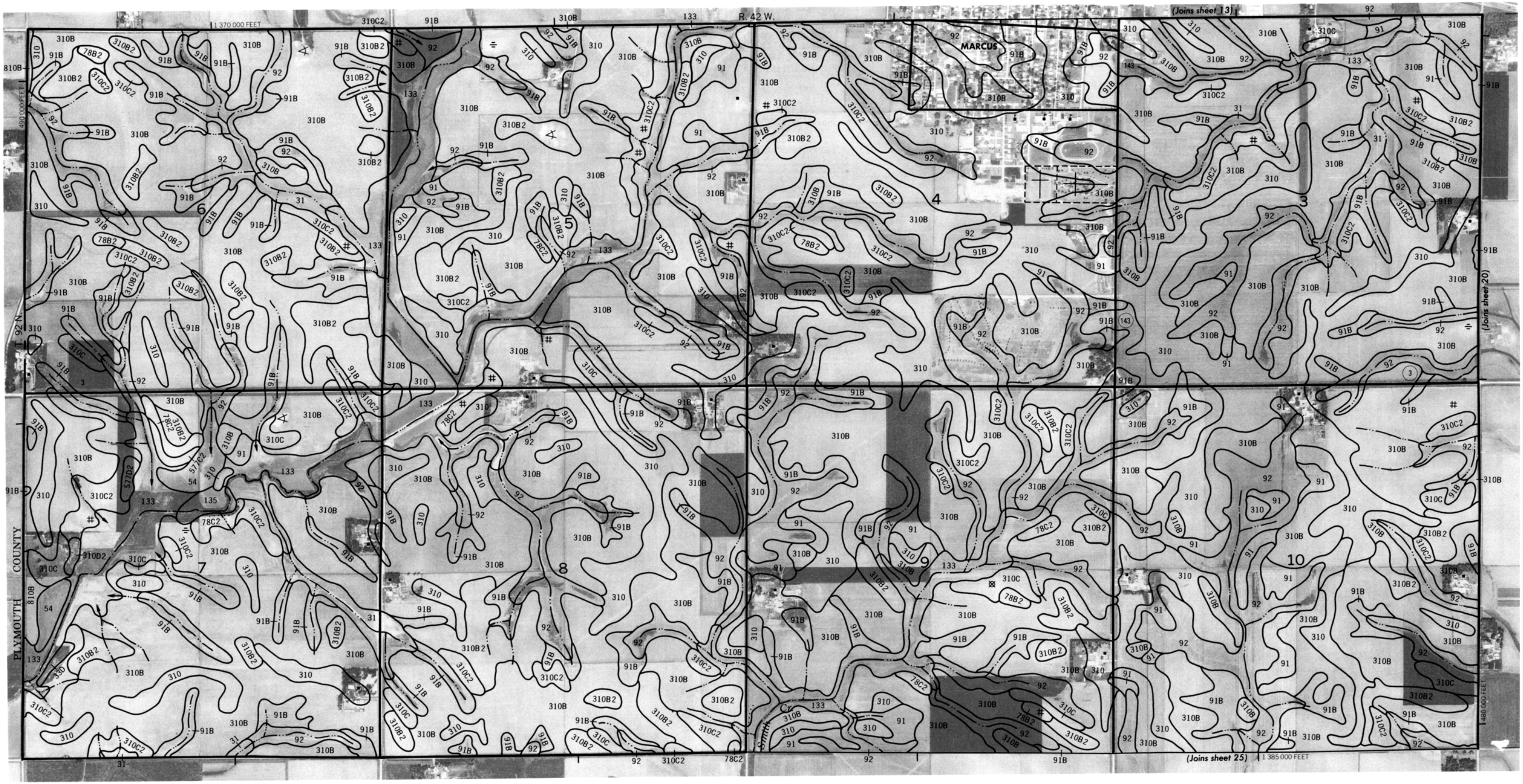
18

N


(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 24)
R. 39 W.
T. 93 N.
BUENA VISTA COUNTY
1 490 000 FEET
1 475 000 FEET
28
27
26
25
33
34
35
36

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 19

N



SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 20

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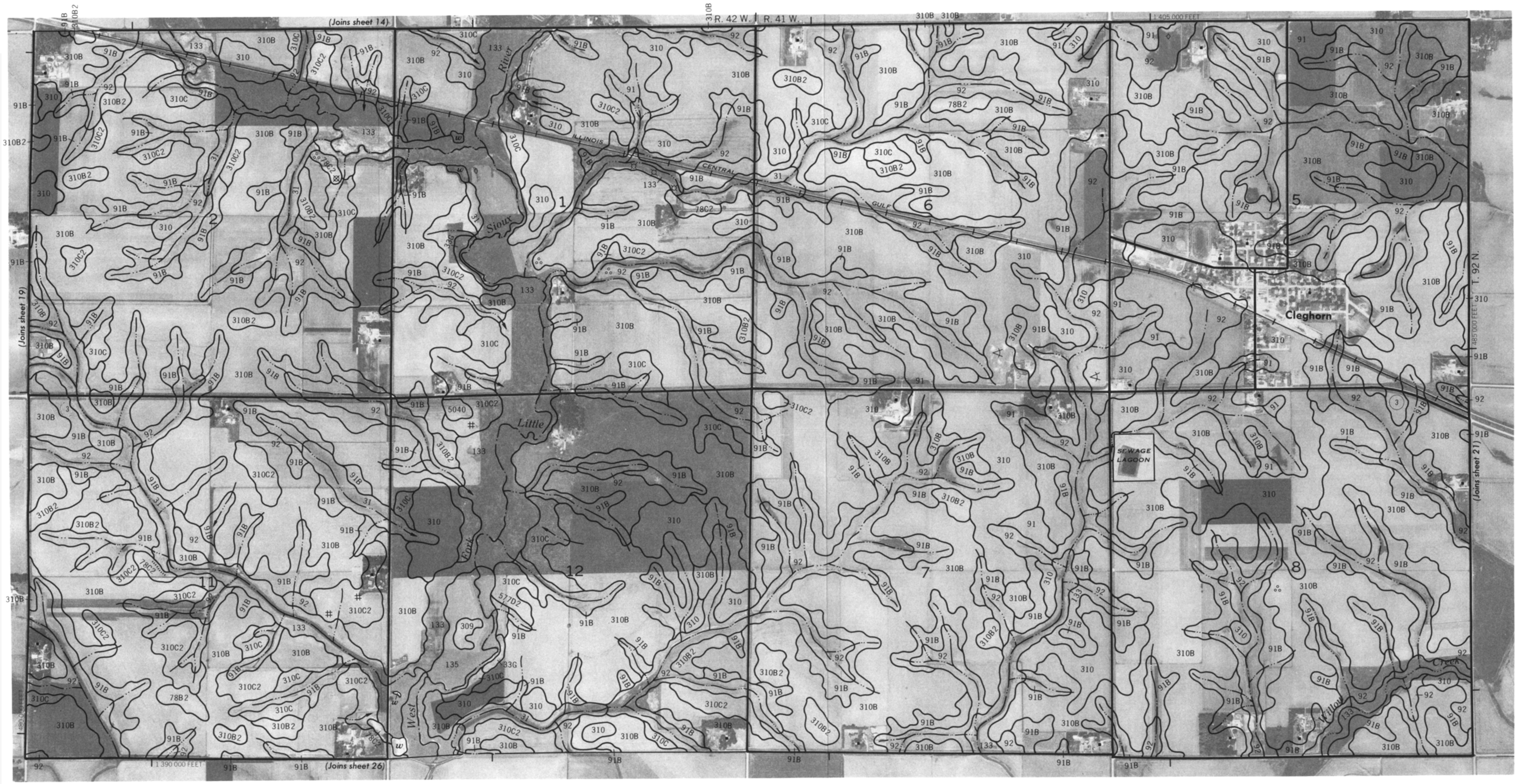
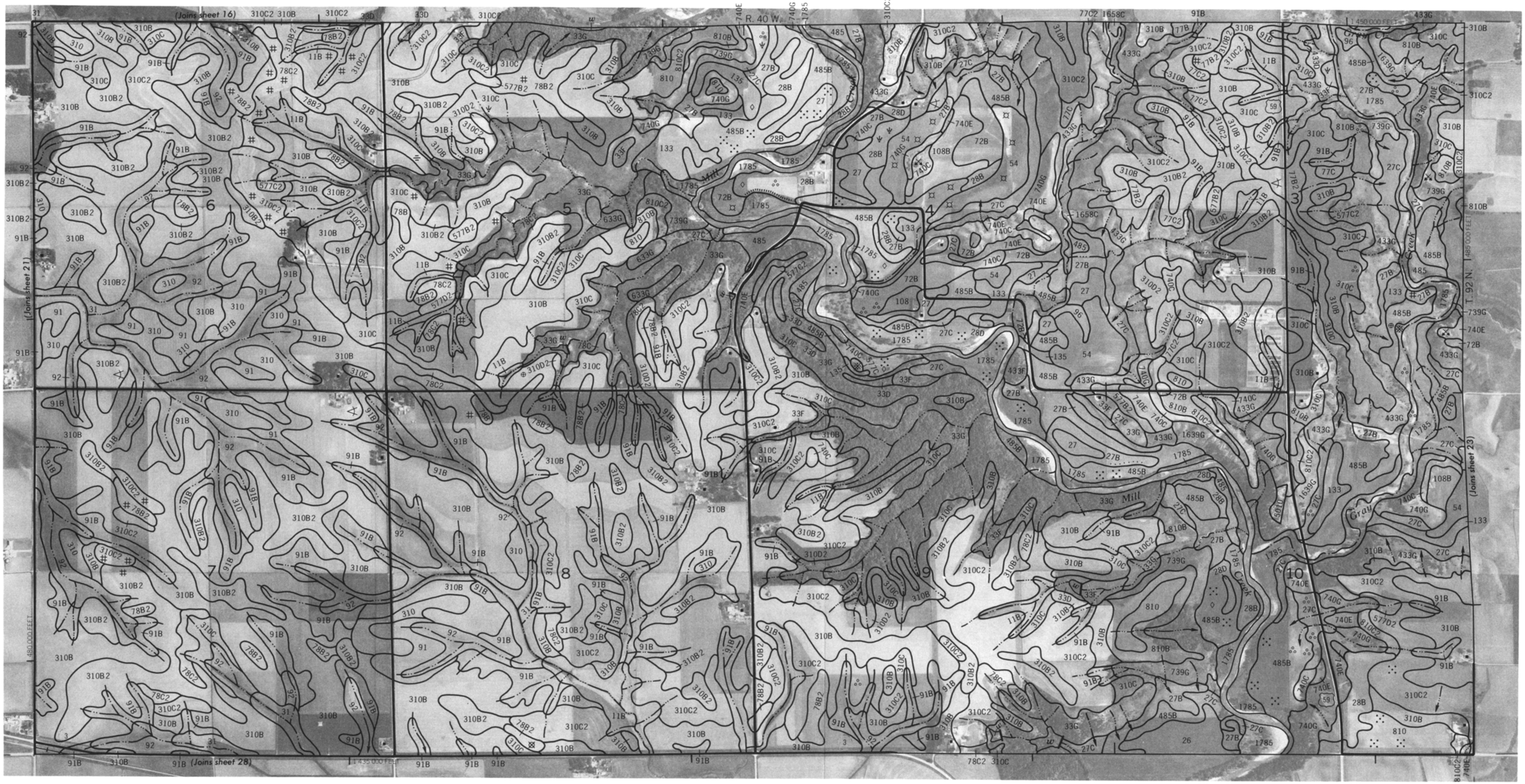


N

R. 41 W.
T. 92 N.
1 410 000 FEET
1 430 000 FEET
485 000 FEET
480 000 FEET
(Joins sheet 15)
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 27)
Bear Creek
Gere Creek
Creek
Willow Cr.
ILLINOIS CENTRAL GULF
Meriden
S.L.
1
2
3
4
9
10
11
12

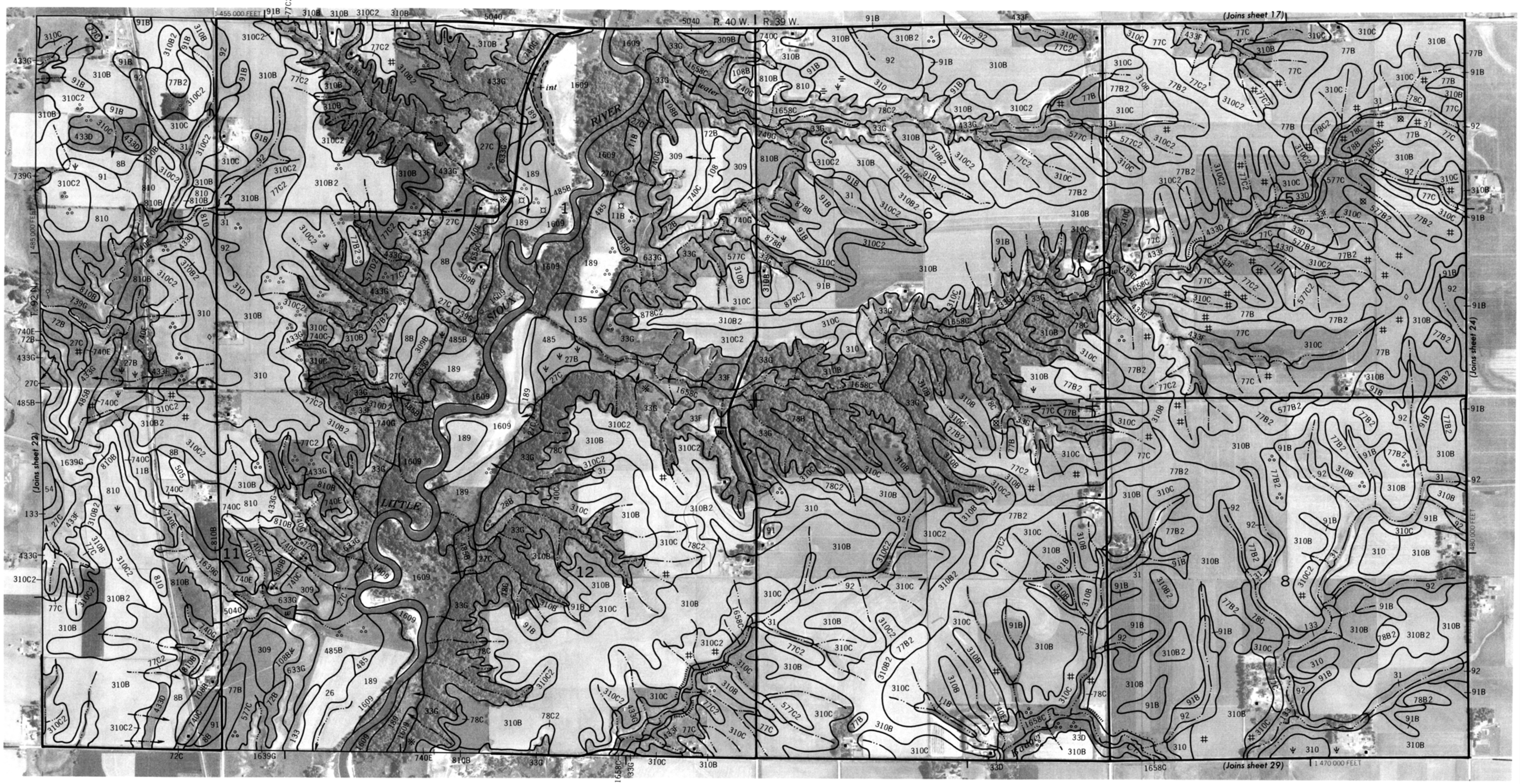
N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 22



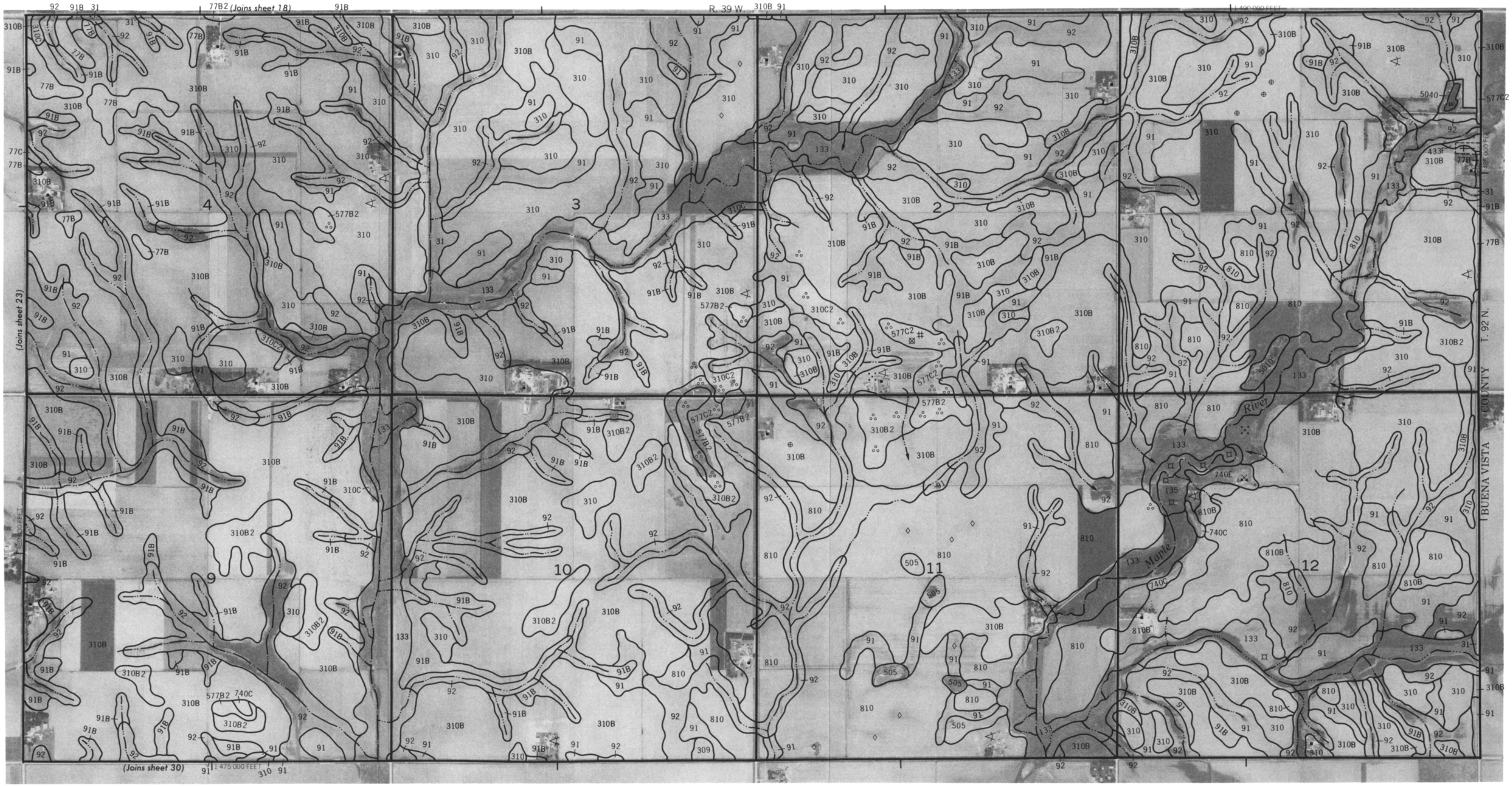
23

N


(Joins sheet 17)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 29)
455 000 FEET
485 000 FEET
480 000 FEET
1 470 000 FEET
R. 40 W.
R. 39 W.
T. 92 N.
LITTLE
SIOUX
RIVER
water
int

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 24

N



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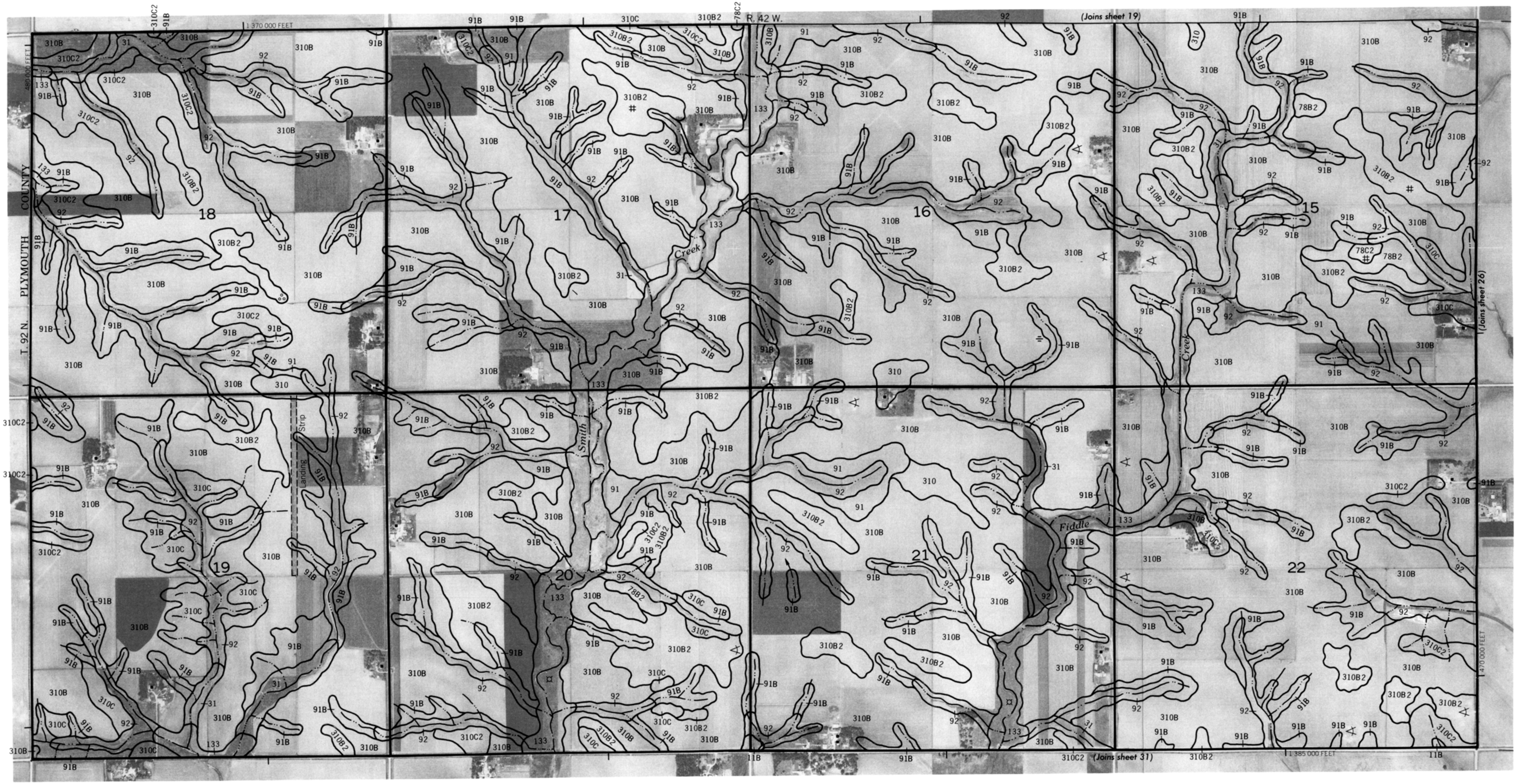
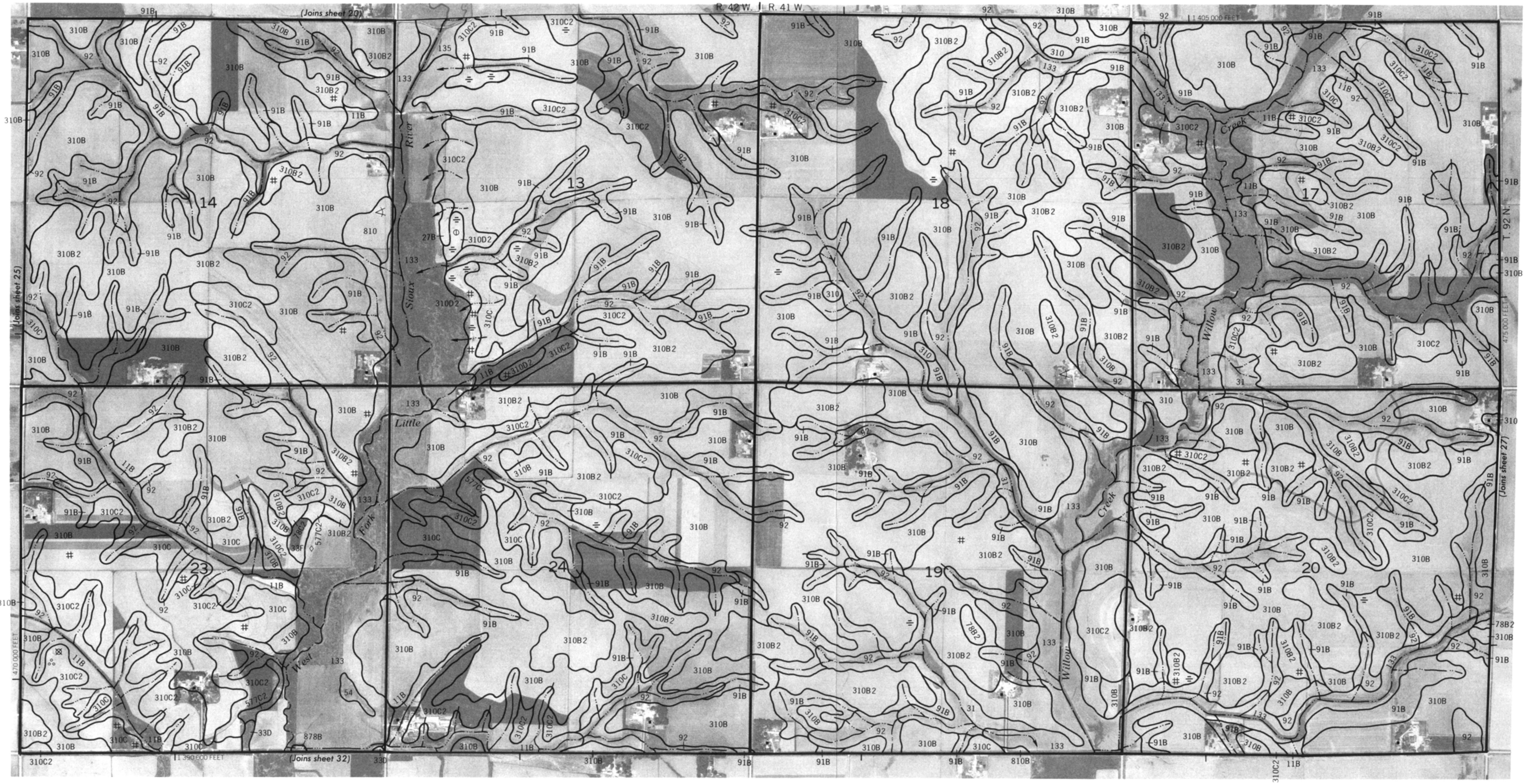
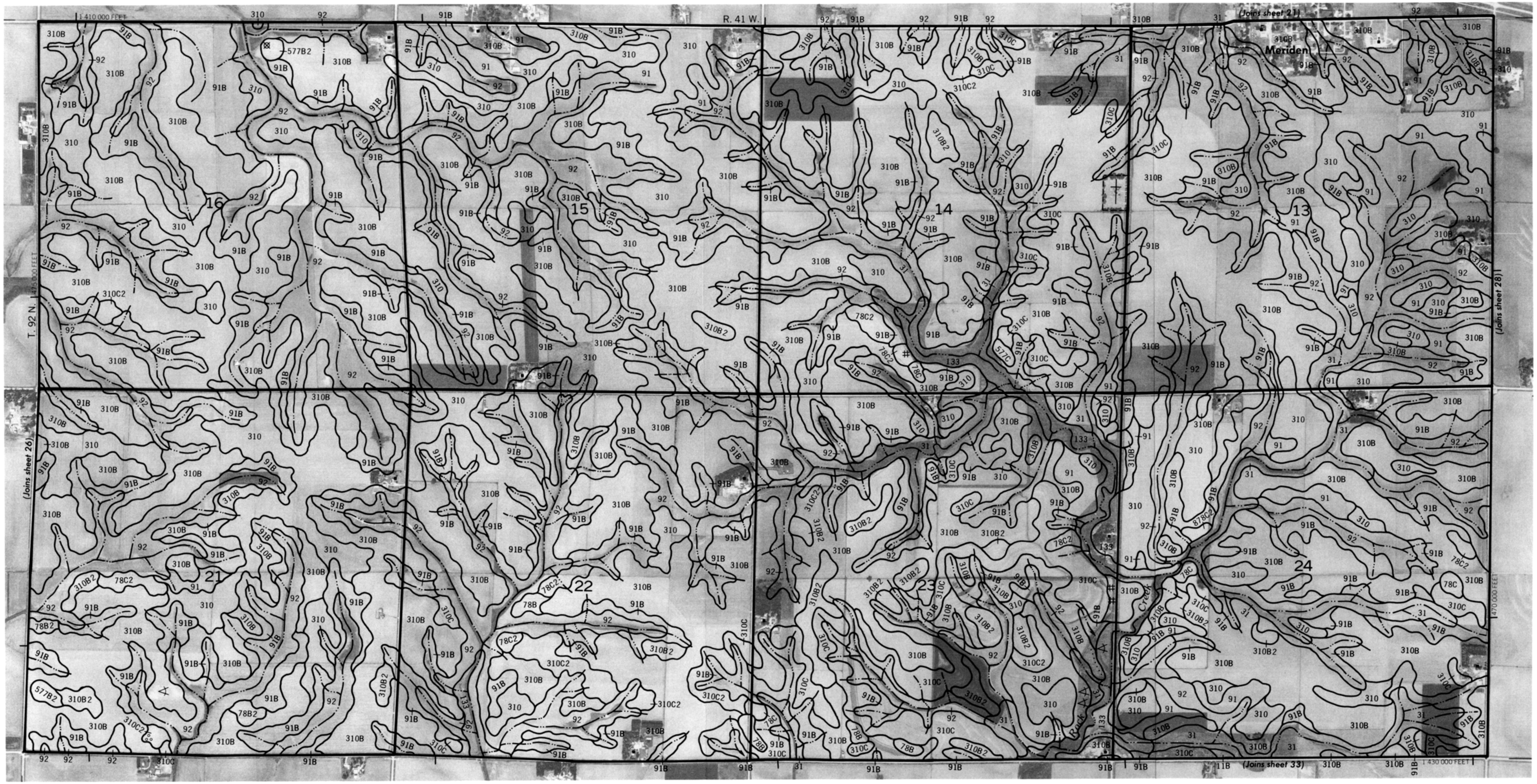

(Joins sheet 19)
(Joins sheet 26)
(Joins sheet 31)
R. 42 W.
T. 92 N.
PLYMOUTH COUNTY
1 370 000 FEET
1 385 000 FEET
485 000 FEET
470 000 FEET
Smith
Creek
Fiddle
Creek
Landing Strip
18
17
16
15
19
20
21
22

N

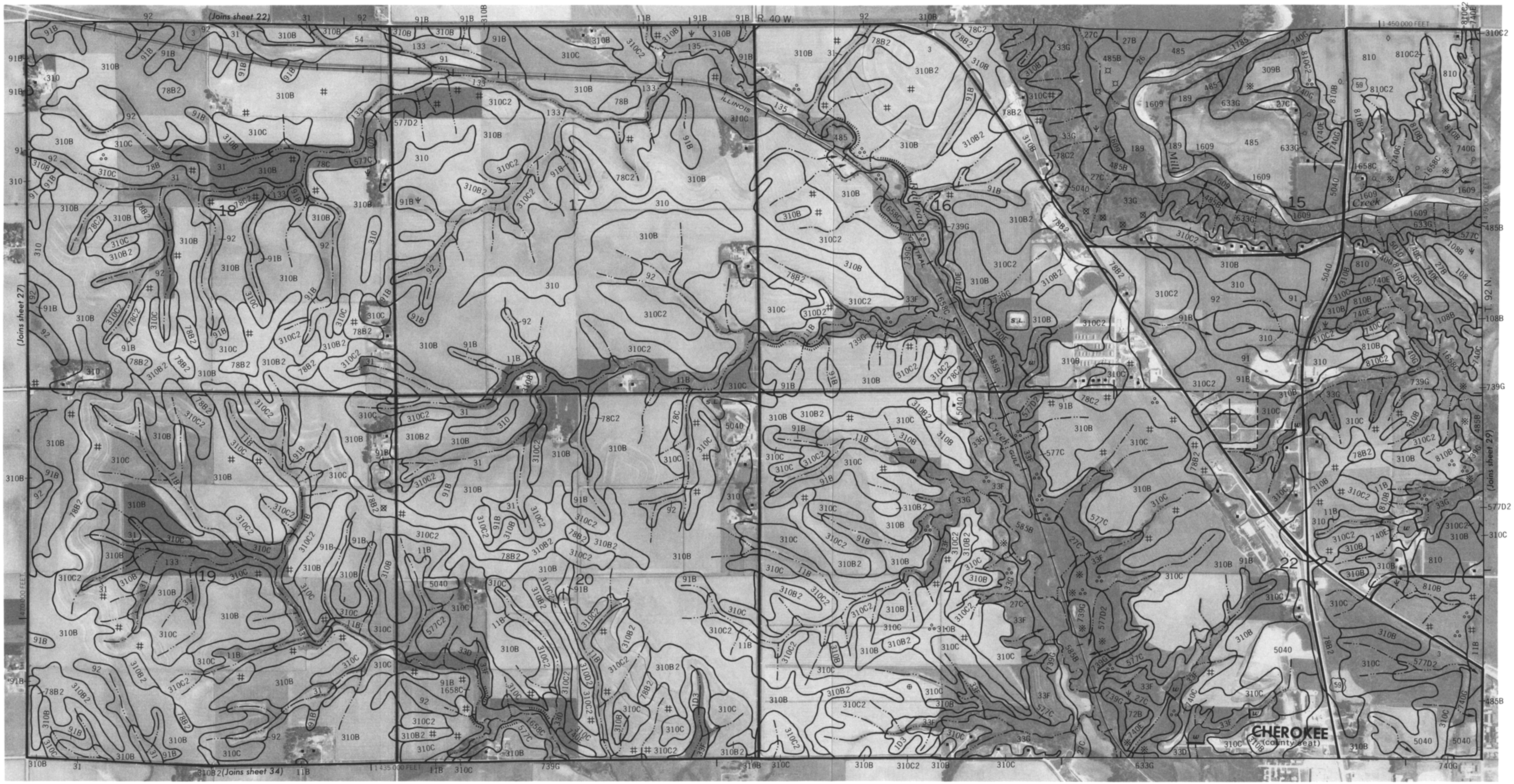

(Joins sheet 20)
R. 42 W.
R. 41 W.
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 32)
T. 92 N.
1 405 000 FEET
1 390 000 FEET
470 000 FEET
475 000 FEET
Little Sioux River
West Fork
Willow Creek
14
13
18
17
23
24
19
20

N


R. 41 W.
T. 92 N.
(Joins sheet 21)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 33)
Meriden
Rock Creek
1 410 000 FEET
1 430 000 FEET
470 000 FEET
16
15
14
13
21
22
23
24

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 28

N



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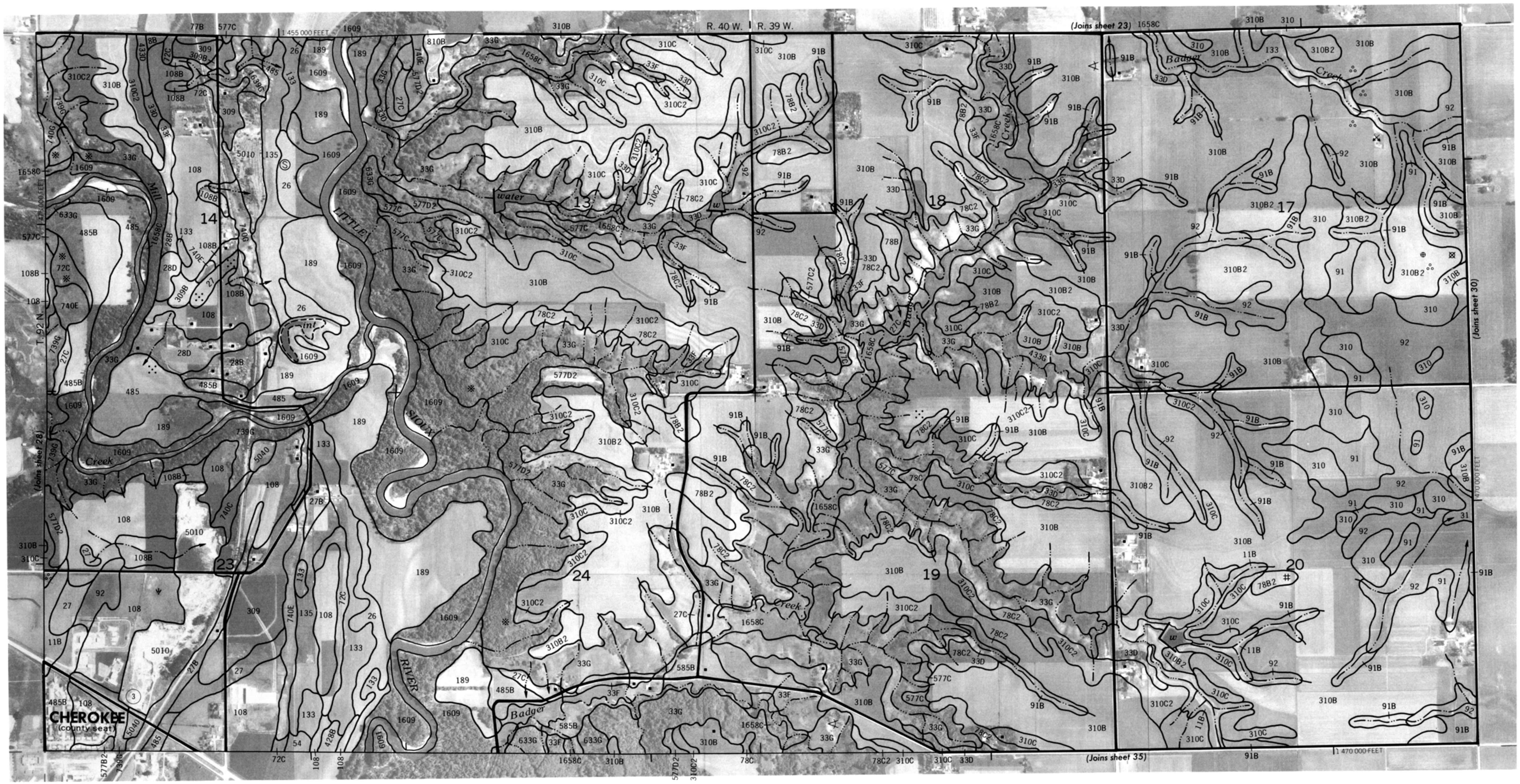
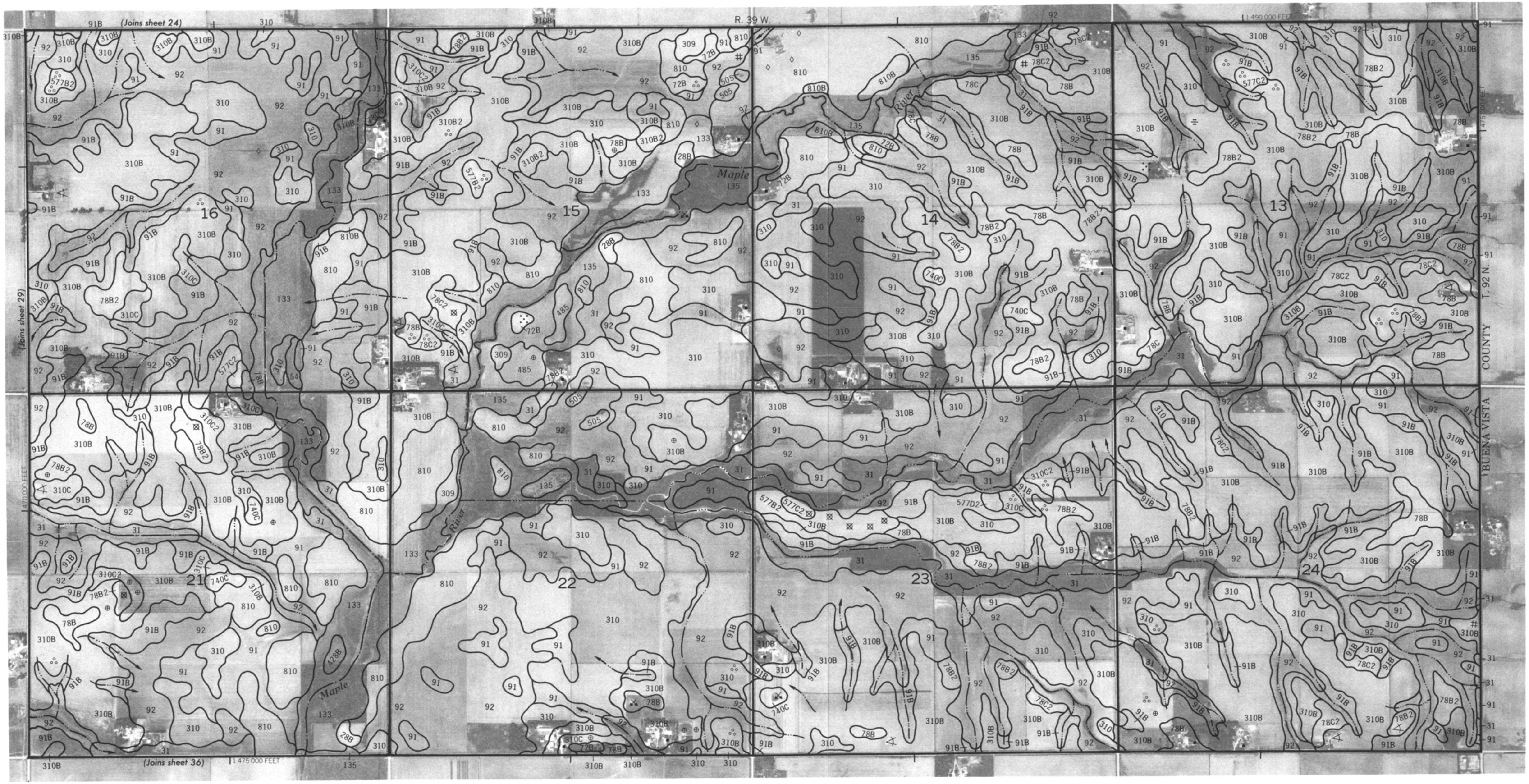

R. 40 W.
R. 39 W.
(Joins sheet 23)
(Joins sheet 30)
(Joins sheet 35)
(Joins sheet 28)
T. 92 N.
1 455 000 FEET
470 000 FEET
1 470 000 FEET
LITTLE SIOUX RIVER
Mill Creek
Badger Creek
Creek
water
CHEROKEE
(county seat)
13
14
17
18
19
20
23
24

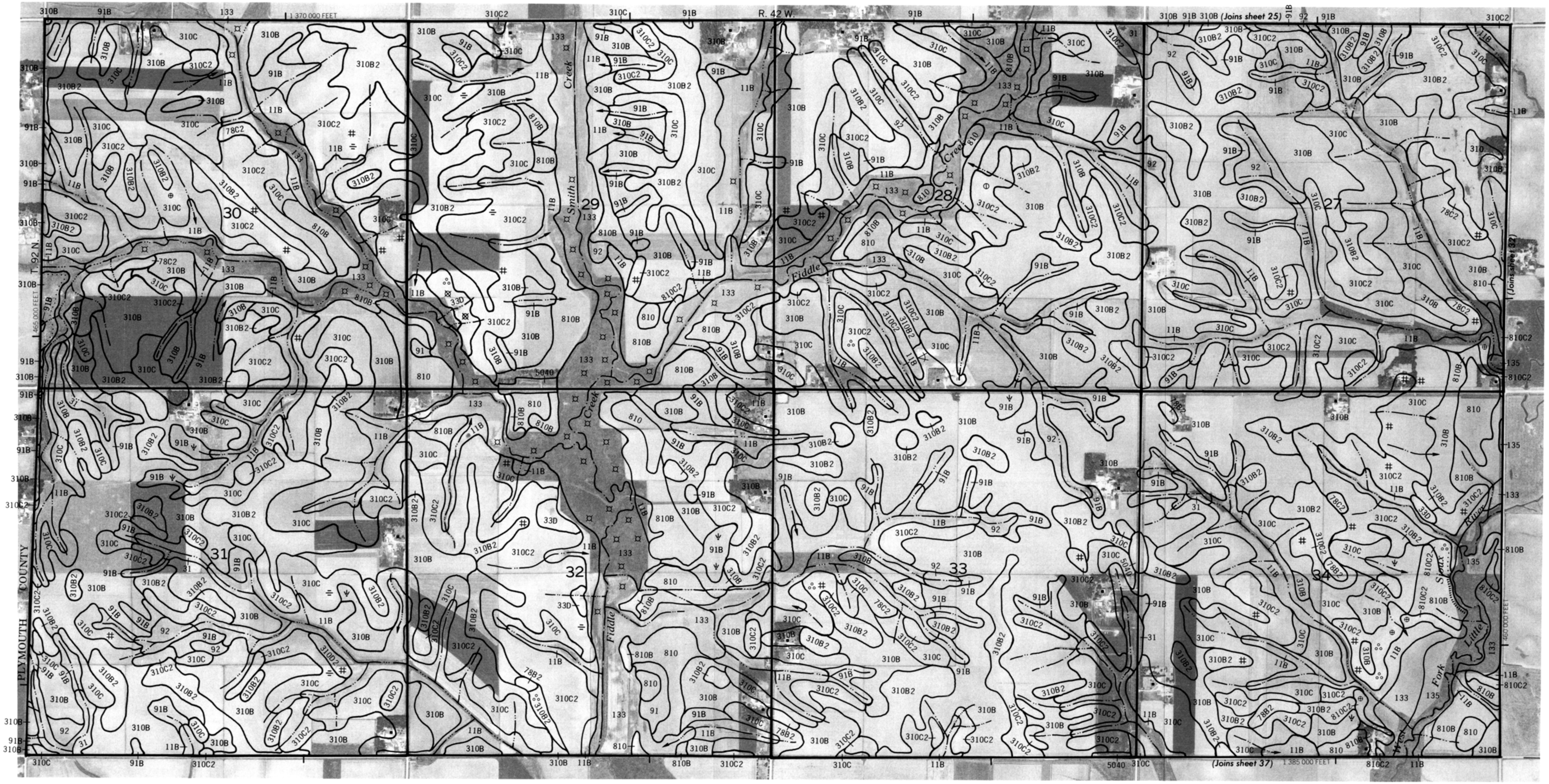
N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 30



31

N



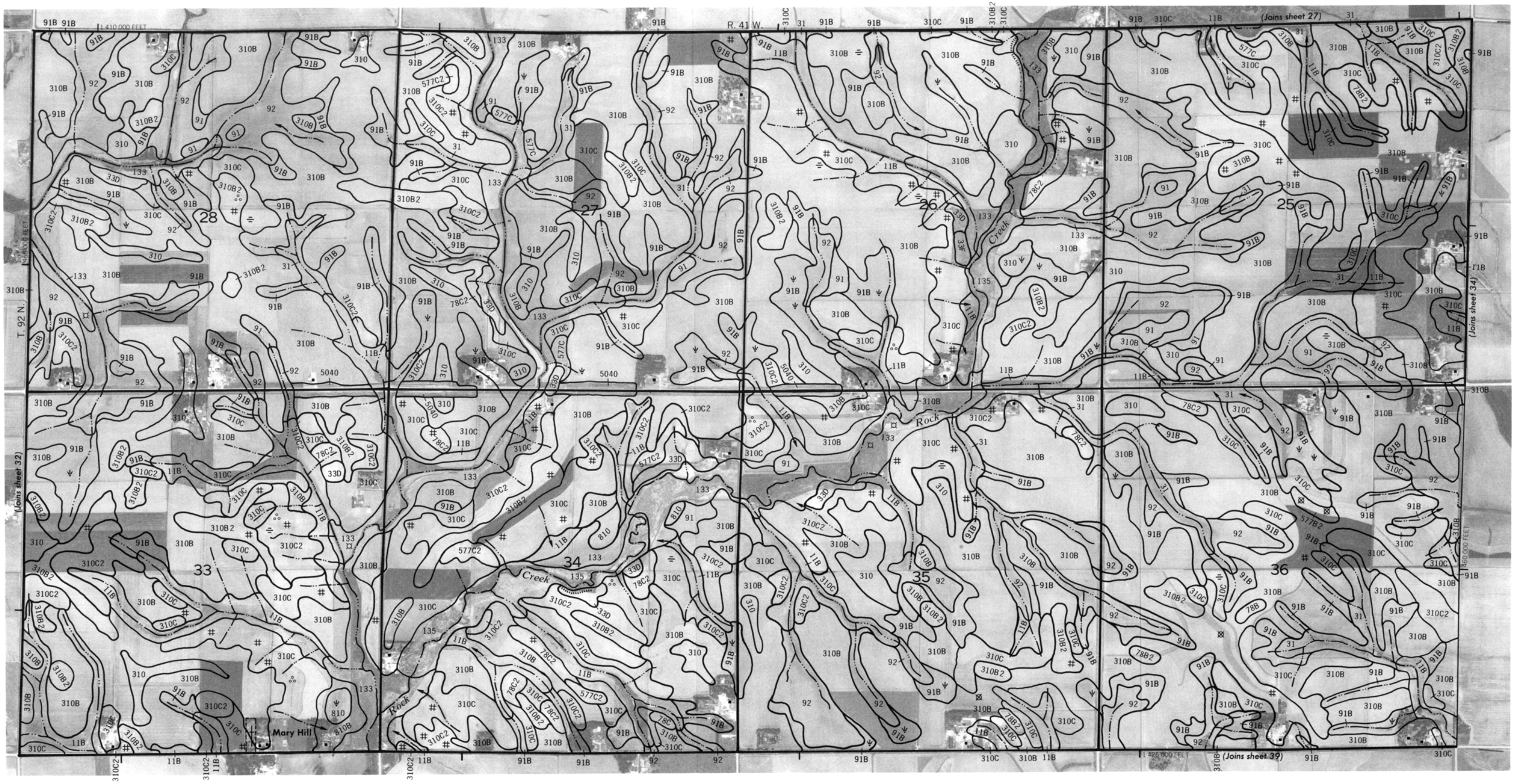
1 370 000 FEET
R. 42 W.
(Joins sheet 25)
(Joins sheet 32)
(Joins sheet 37)
1 385 000 FEET
460 000 FEET
465 000 FEET
T. 92 N.
PLYMOUTH COUNTY
Smith Creek
Fiddle Creek
Creek
Fiddle
West Fork Little Sioux River
30
29
28
27
31
32
33
34

N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 32

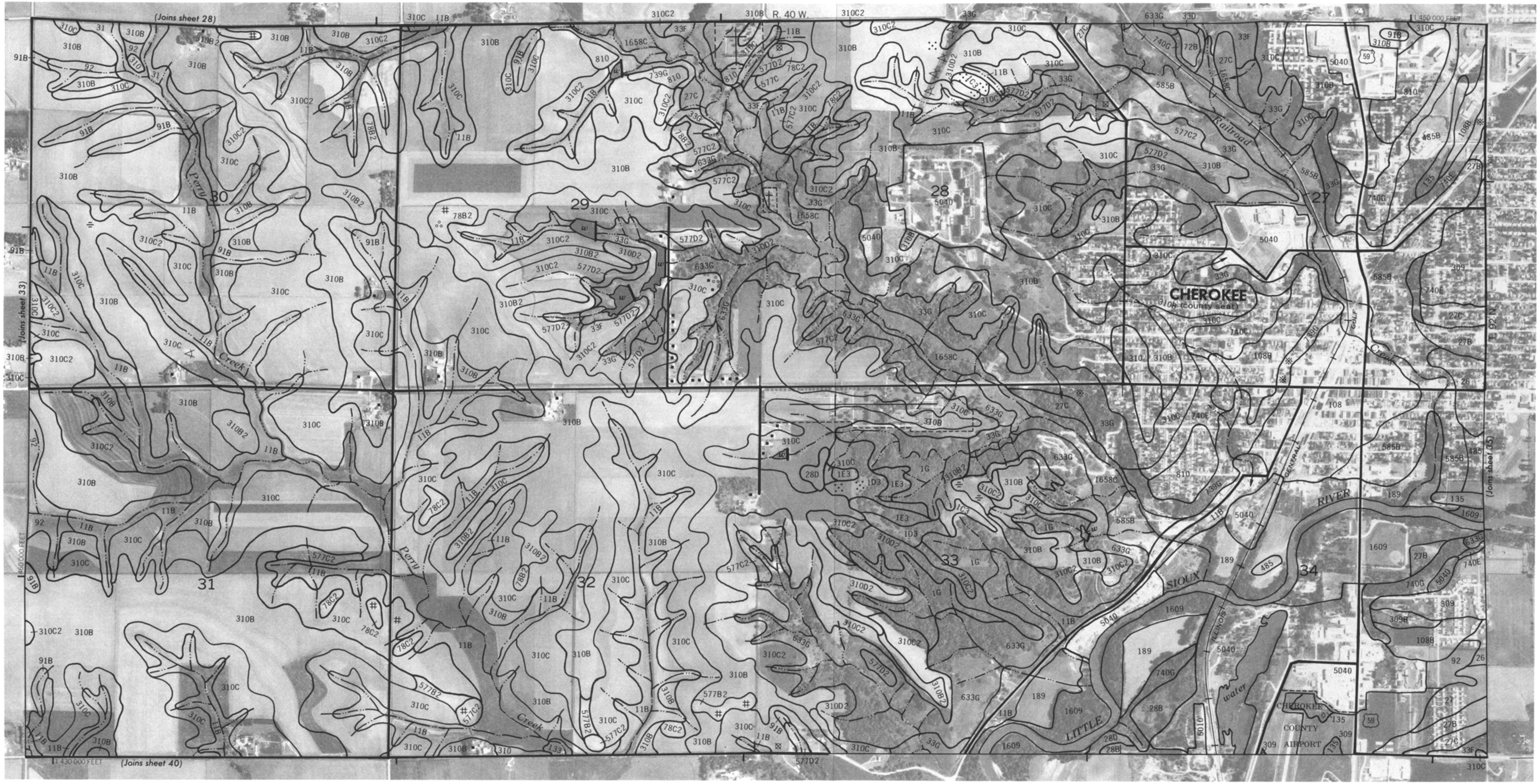
33

N

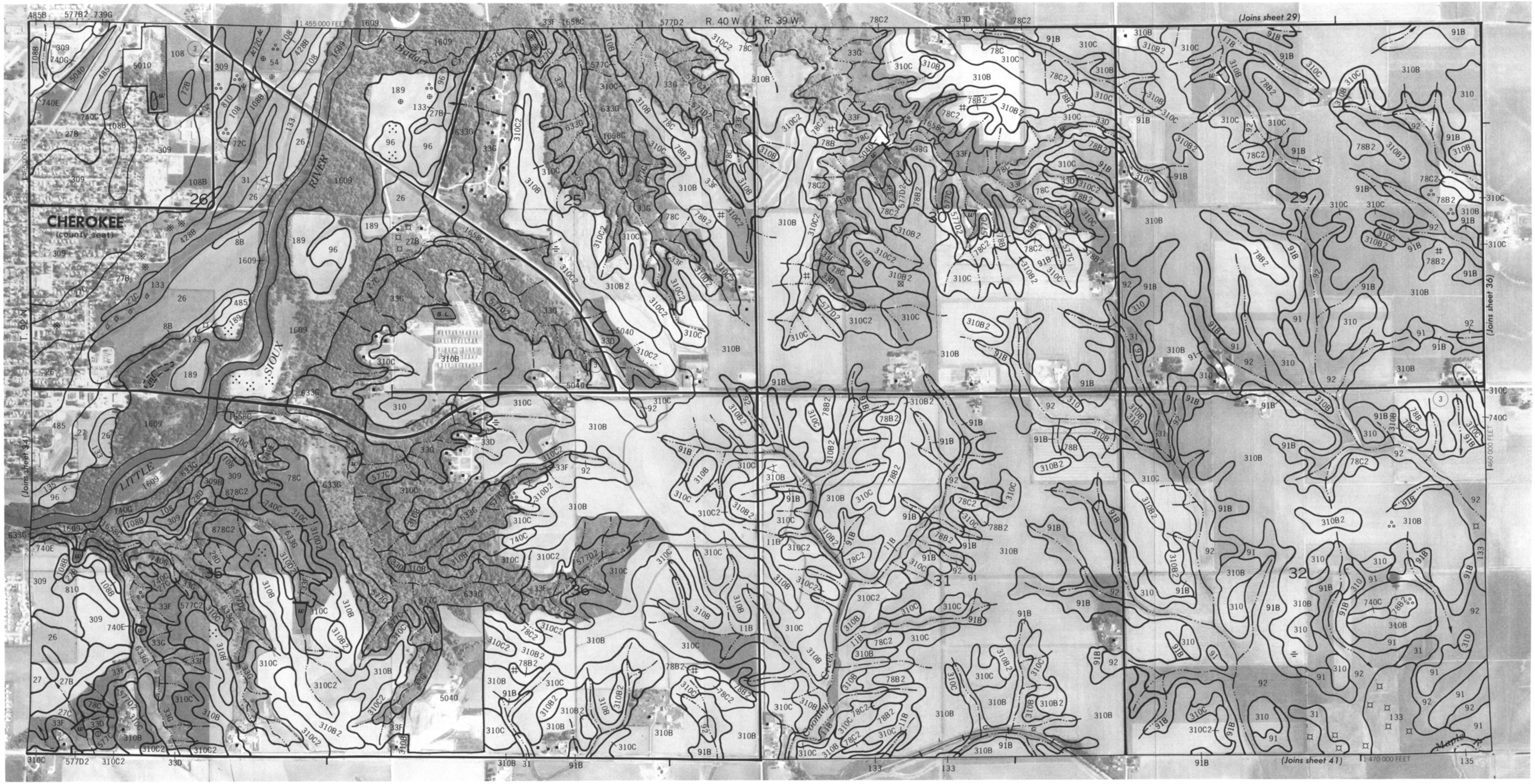

(Joins sheet 27)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 39)
R. 41 W.
T. 92 N.
1 410 000 FEET
1 425 000 FEET
Rock Creek
Mary Hill
28
27
26
25
33
34
35
36

N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 34



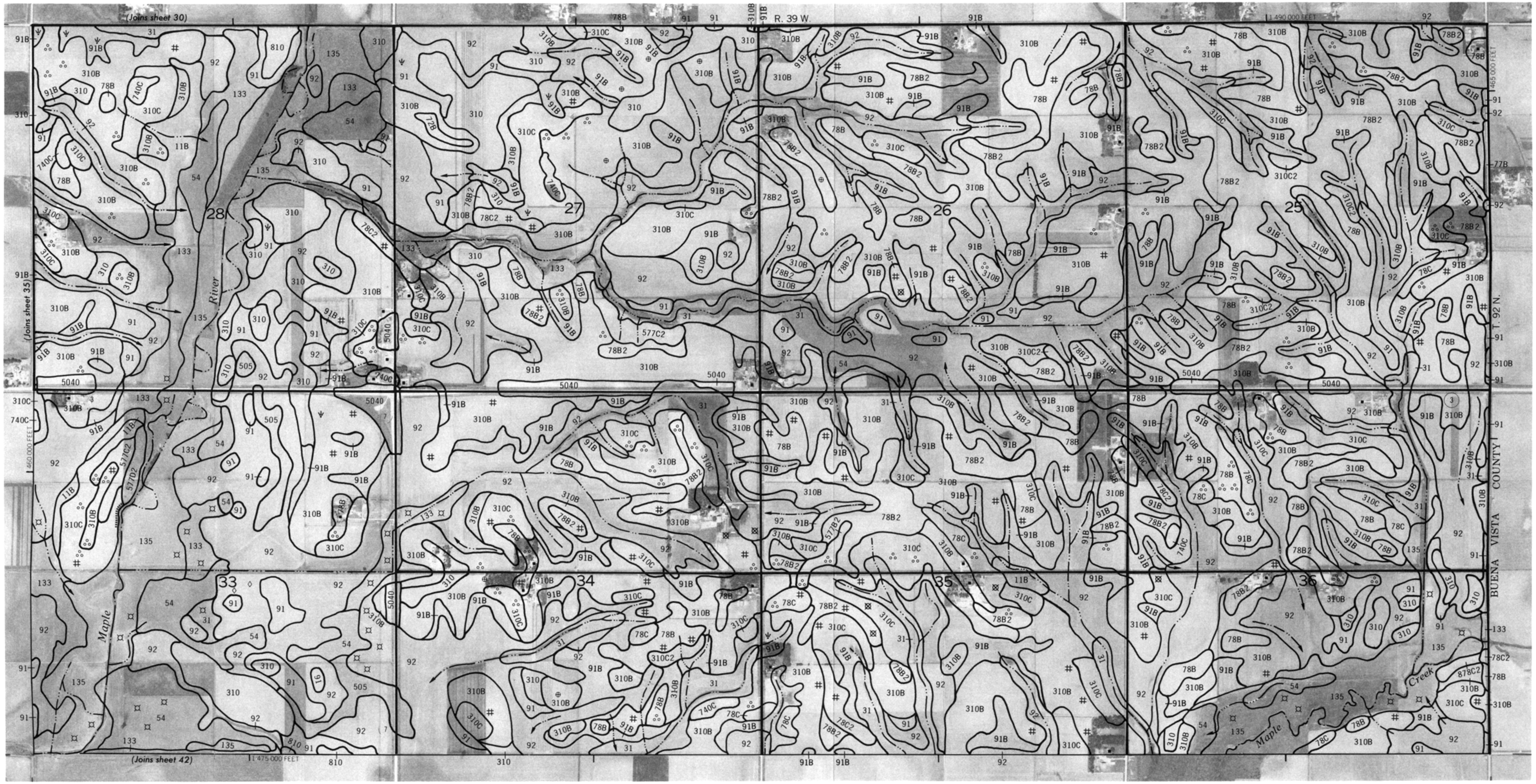
N



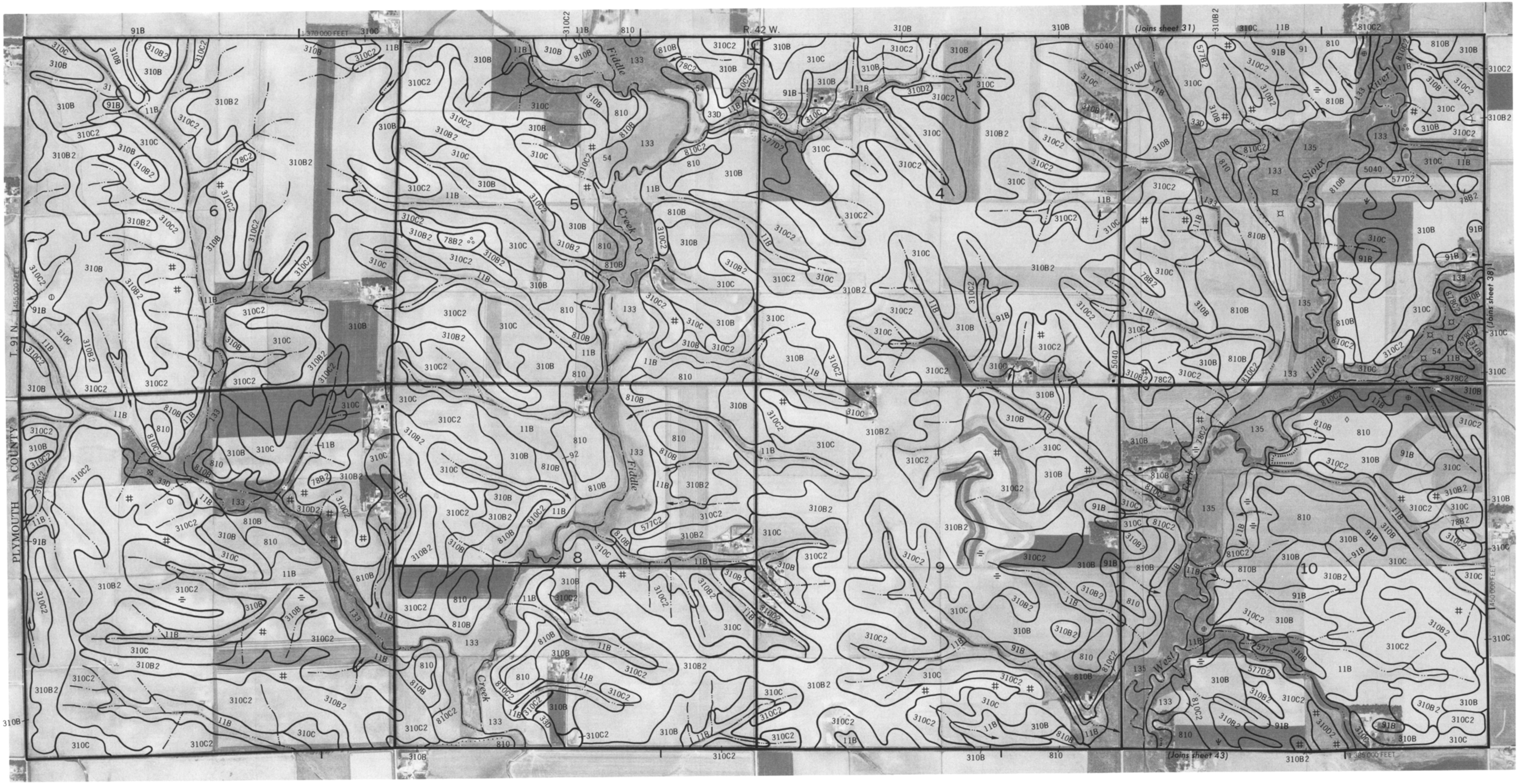
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 41)
(Joins sheet 34)
R. 40 W.
R. 39 W.
T. 92 N.
1 455 000 FEET
1 470 000 FEET
460 000 FEET
CHEROKEE
(county seat)
LITTLE
SIOUX
RIVER
Badger
25
26
29
30
31
32
35
36

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 36

N

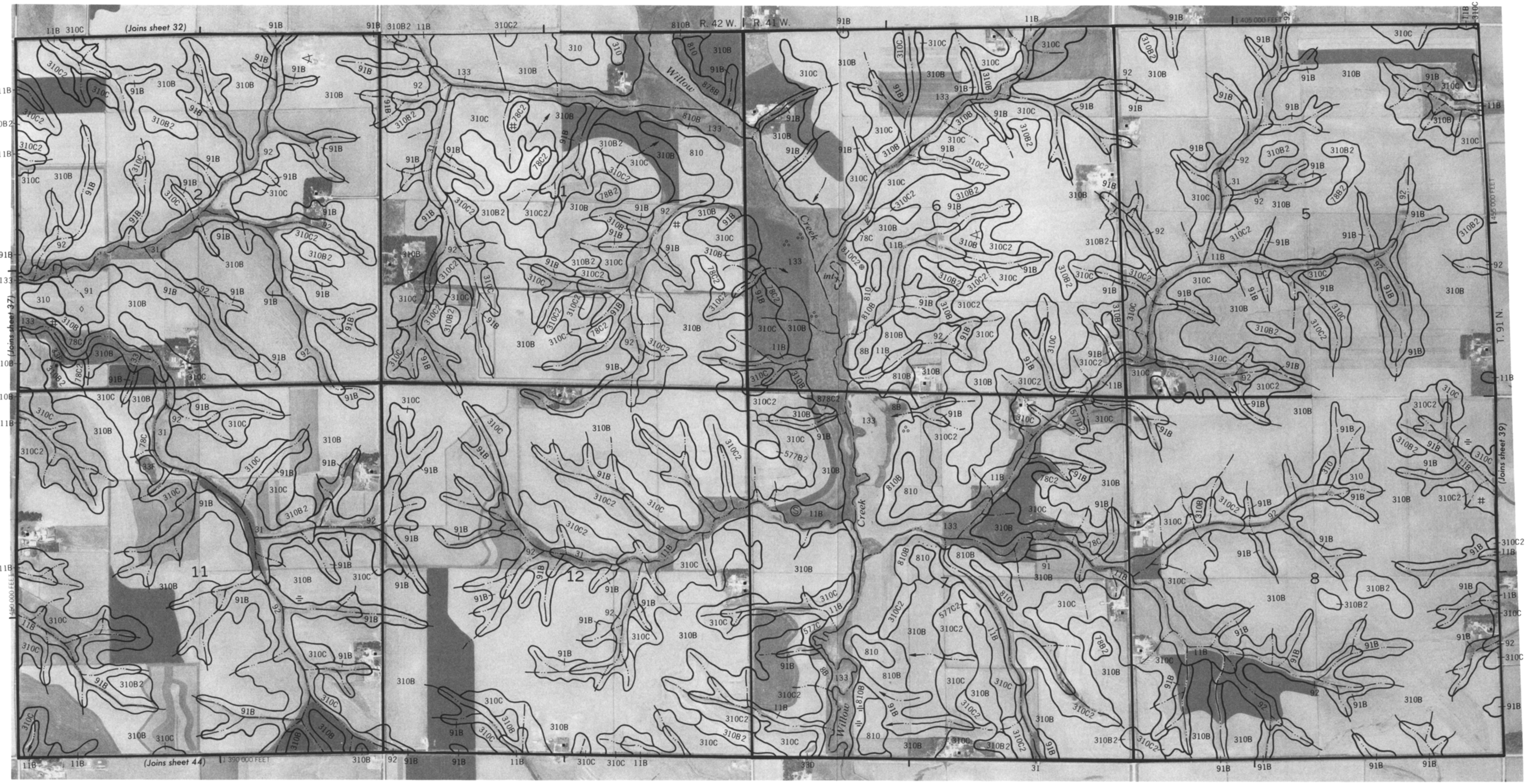


N


R. 42 W.
T. 91 N.
(Joins sheet 31)
(Joins sheet 38)
(Joins sheet 43)
PLYMOUTH COUNTY
Fiddle Creek
Little Sioux River
West Fork
1 370 000 FEET
1 455 000 FEET
1 450 000 FEET
1 385 000 FEET

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 38

N

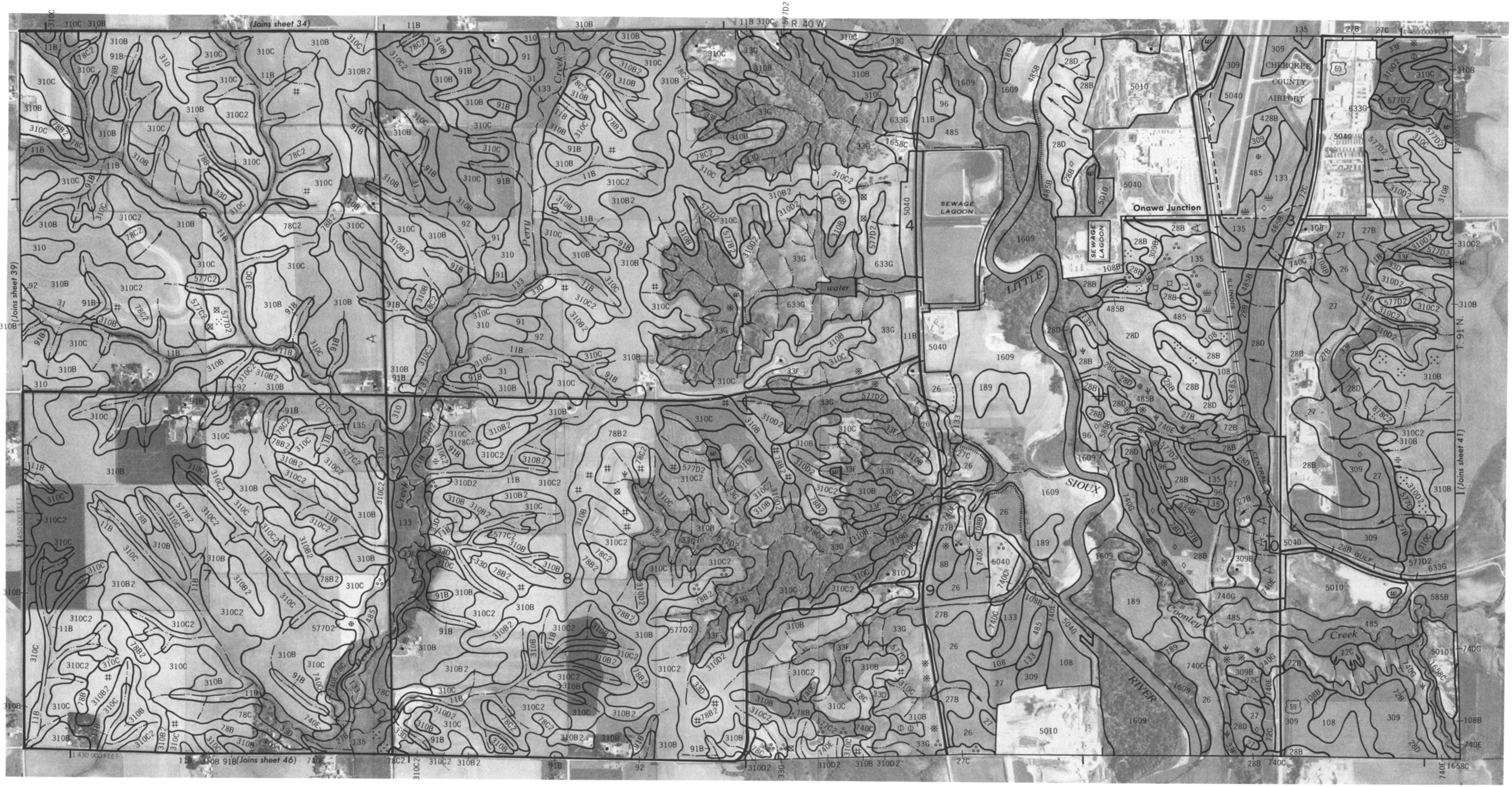


39

N

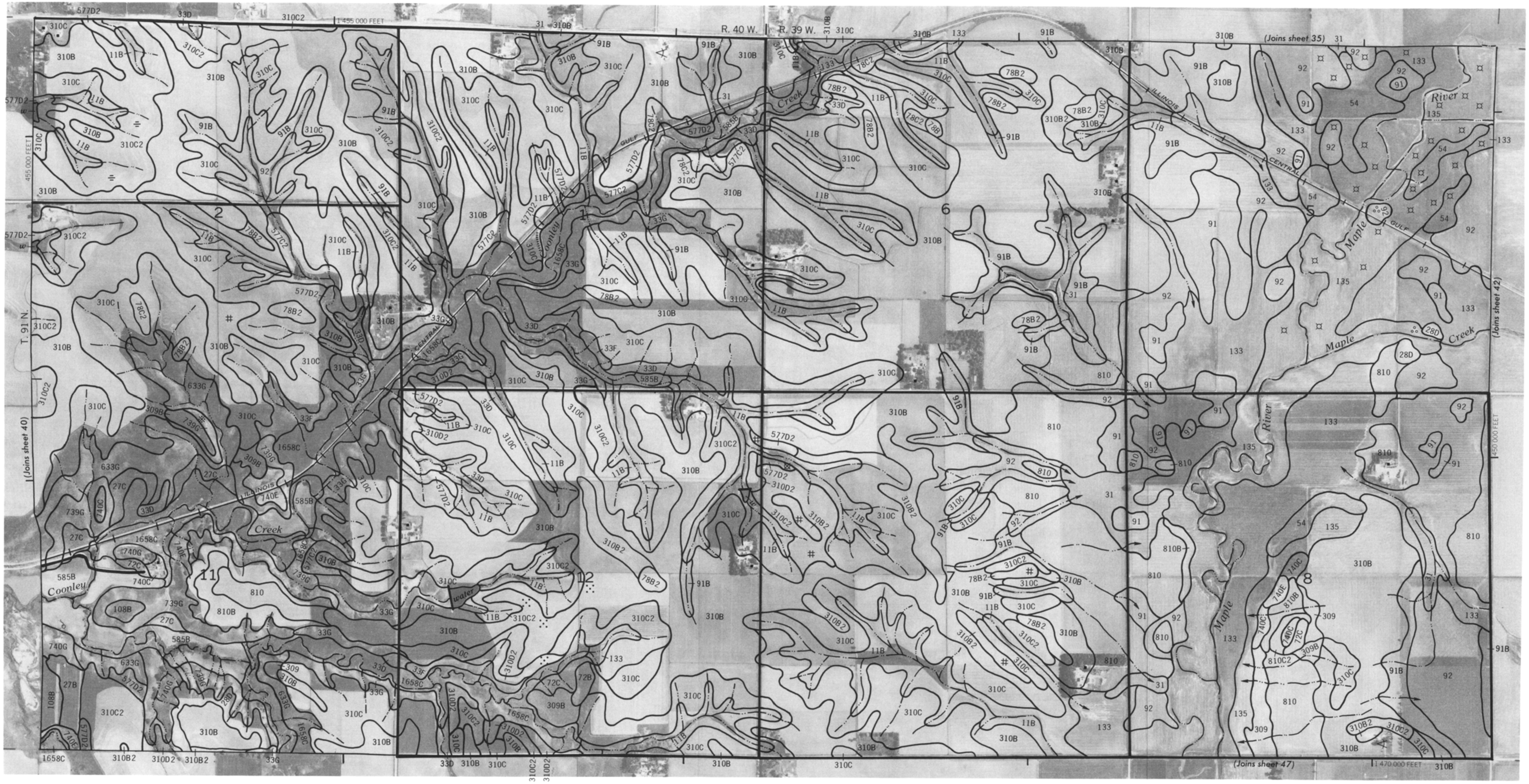

Mary Hill
Rock Creek
R. 41 W.
T. 91 N.
(Joins sheet 33)
(Joins sheet 40)
(Joins sheet 45)
(Joins sheet 38)
1 410 000 FEET
1 425 000 FEET
456 000 FEET
450 000 FEET
1
2
3
4
9
10
11
12

N


(Joins sheet 34)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 46)
R. 40 W.
T. 91 N.
1 450 000 FEET
1 430 000 FEET
CHEROKEE
COUNTY
AIRPORT
Onawa Junction
SEWAGE LAGOON
water
Perry
Creek
LITTLE
SIOUX
RIVER
Coonley
Creek
ILLINOIS
CENTRAL
GULF

41

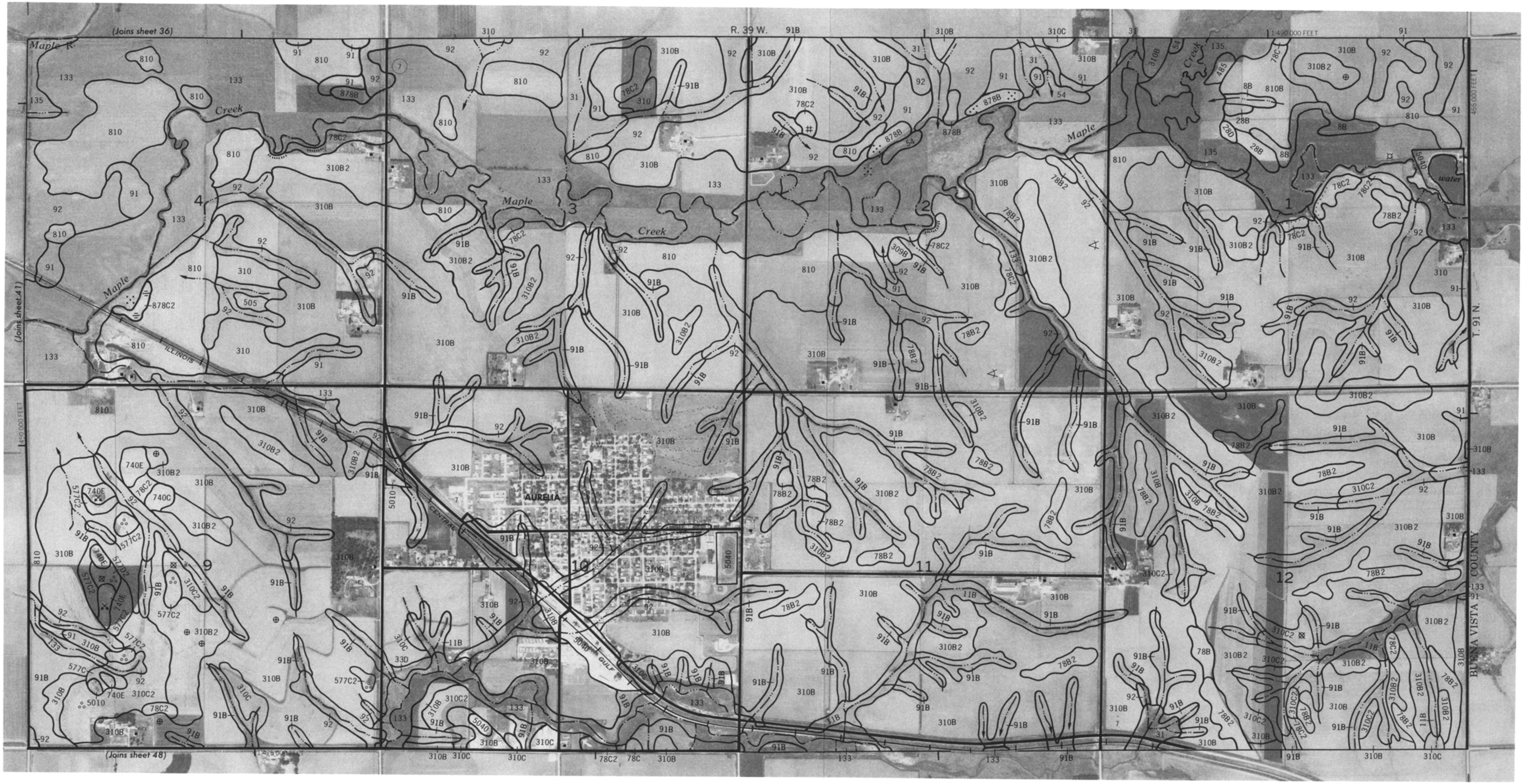
N



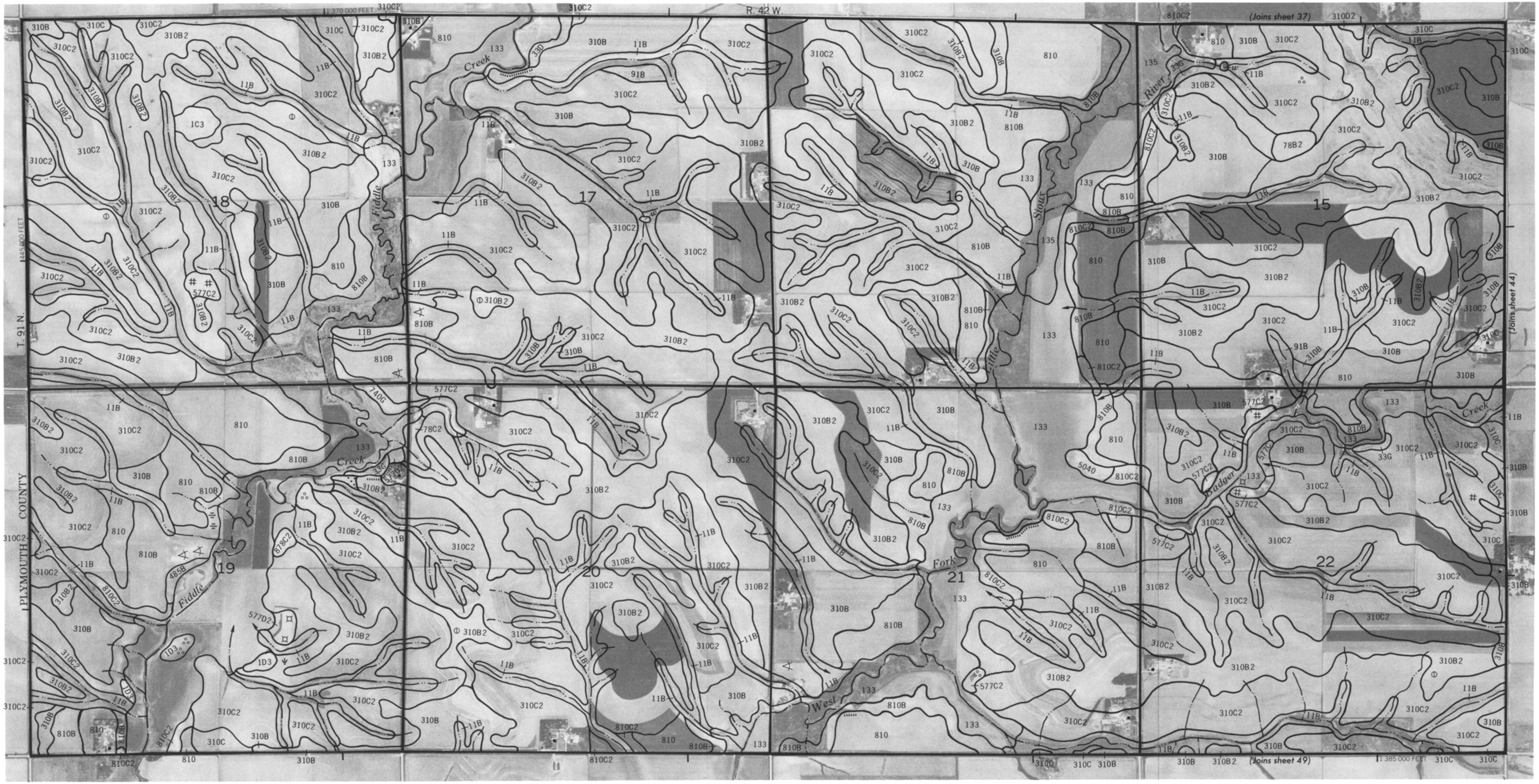
R. 40 W.
R. 39 W.
T. 91 N.
1 455 000 FEET
455 000 FEET
450 000 FEET
1 470 000 FEET
(Joins sheet 35)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 47)
ILLINOIS CENTRAL GULF
Coonley Creek
Maple River
Maple Creek
water
1
2
5
6
7
8
11
12

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 42

N



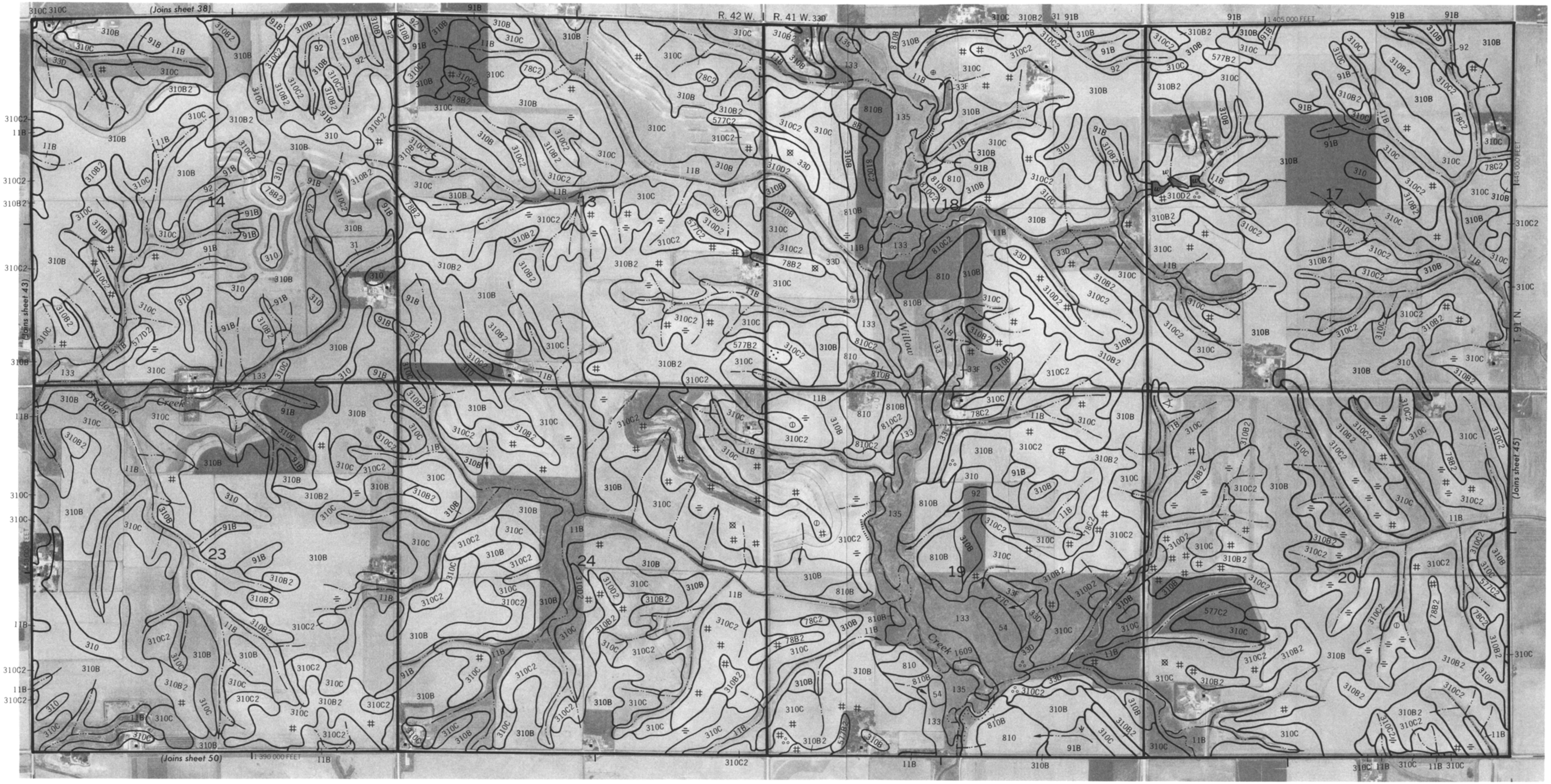
N



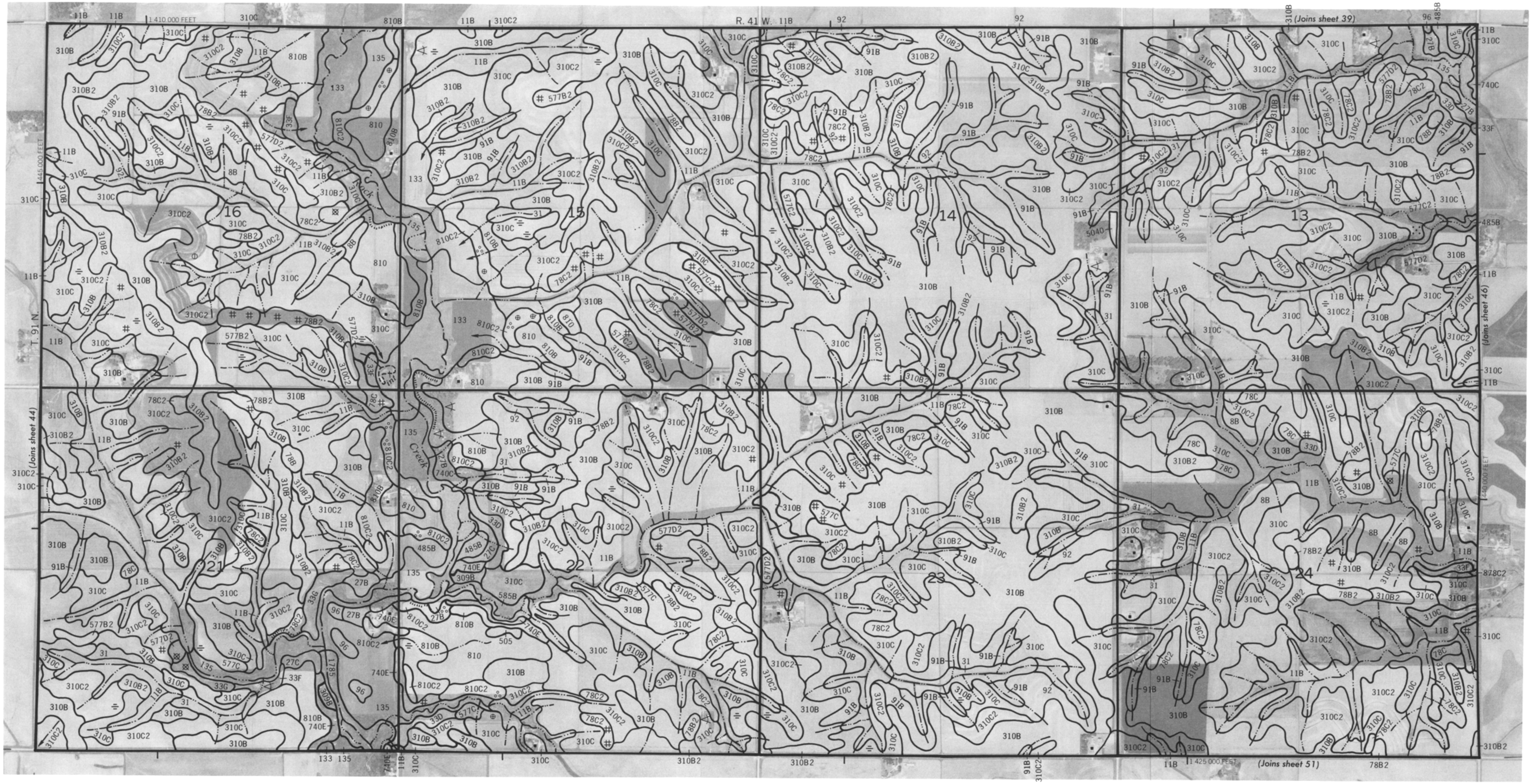
1 370 000 FEET
R. 42 W.
(Joins sheet 37)
(Joins sheet 44)
(Joins sheet 49)
1 385 000 FEET
145 000 FEET
T. 91 N.
PLYMOUTH COUNTY
18
17
16
15
19
20
21
22
Fiddle
Creek
Little
Sioux
River
Badger
Creek
West
Fork

N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 44



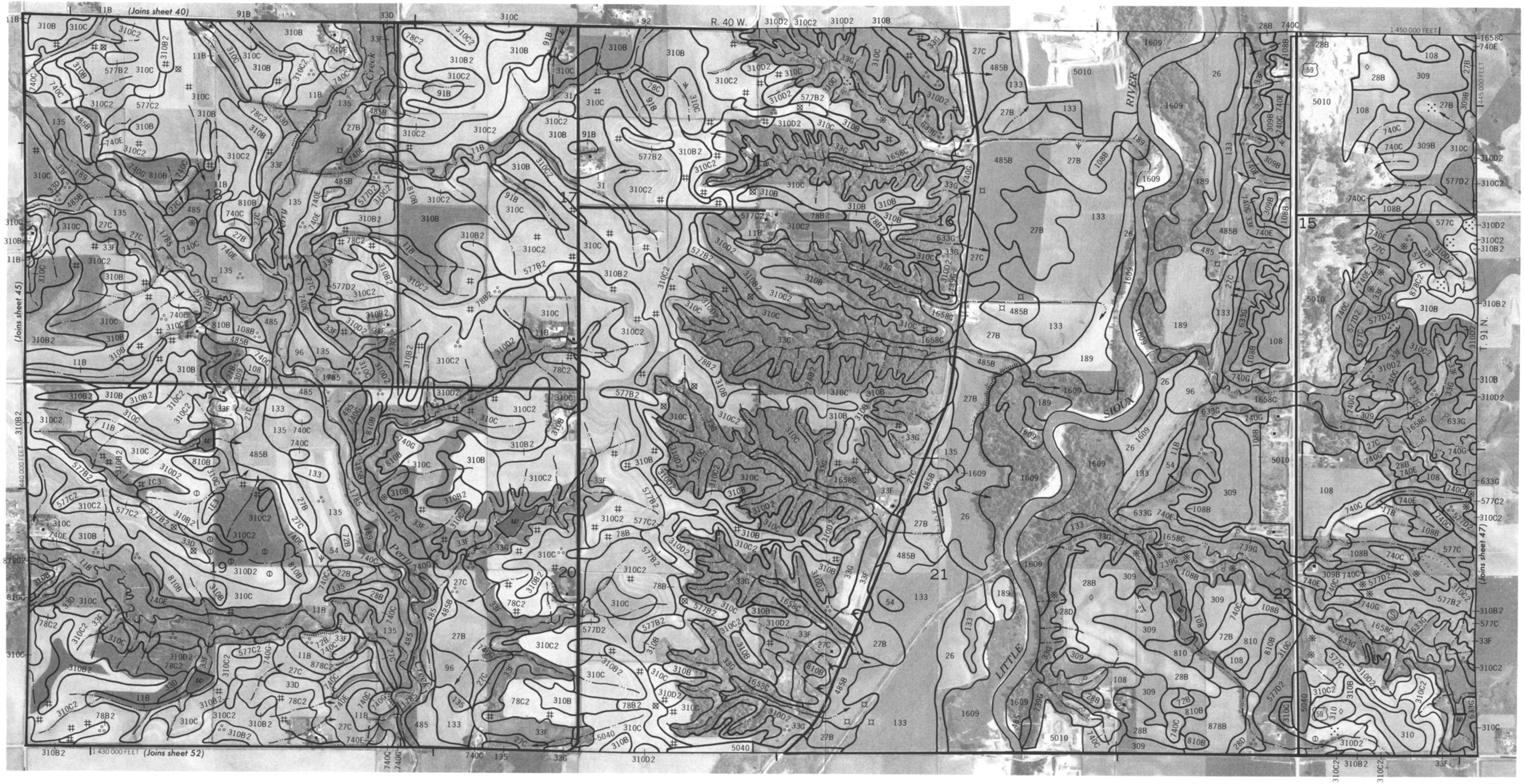
N



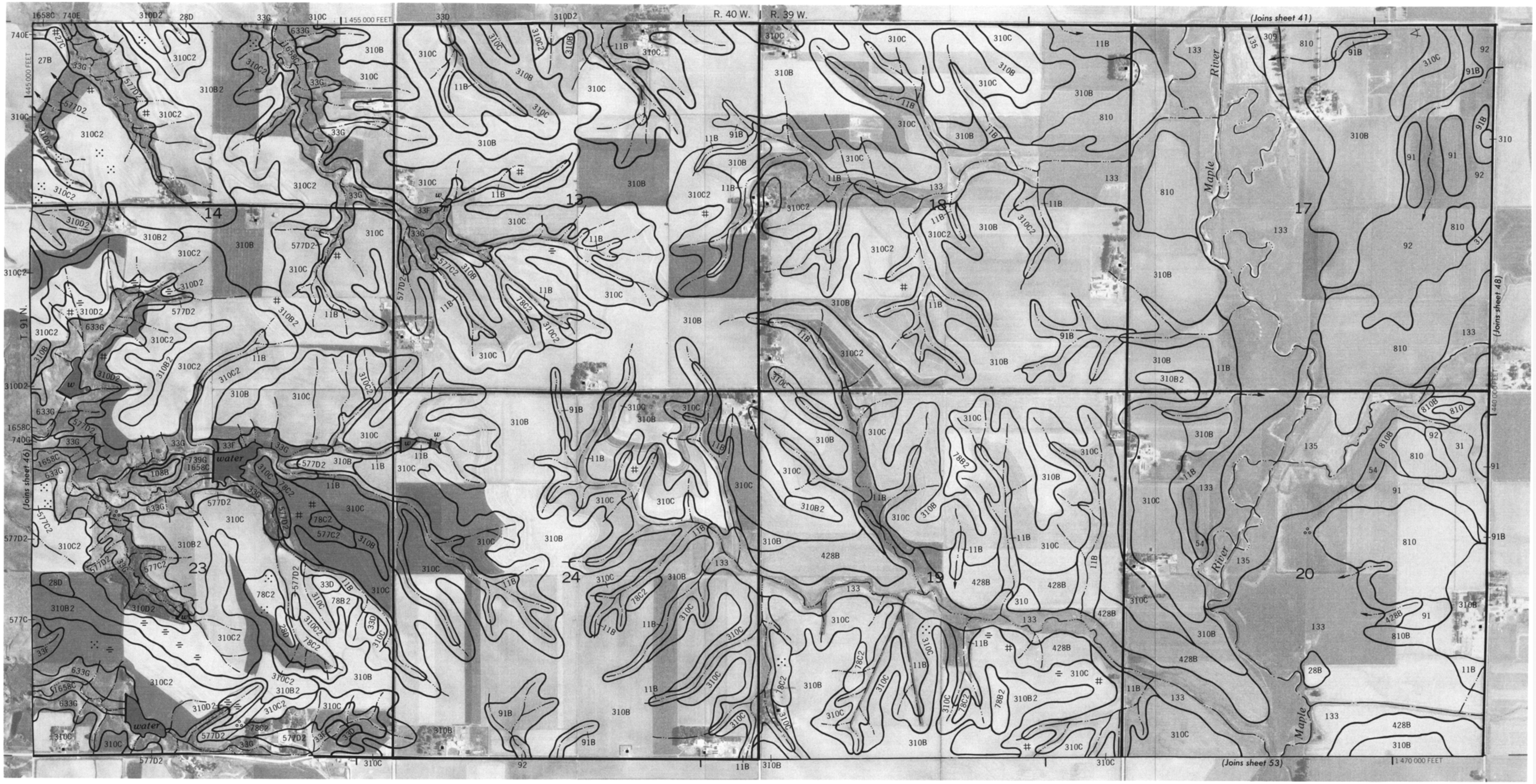
R. 41 W.
T. 91 N.
(Joins sheet 39)
(Joins sheet 44)
(Joins sheet 46)
(Joins sheet 51)
1 410 000 FEET
1 425 000 FEET
445 000 FEET
440 000 FEET
Rock Creek
16
15
14
13
21
22
23
24

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 46

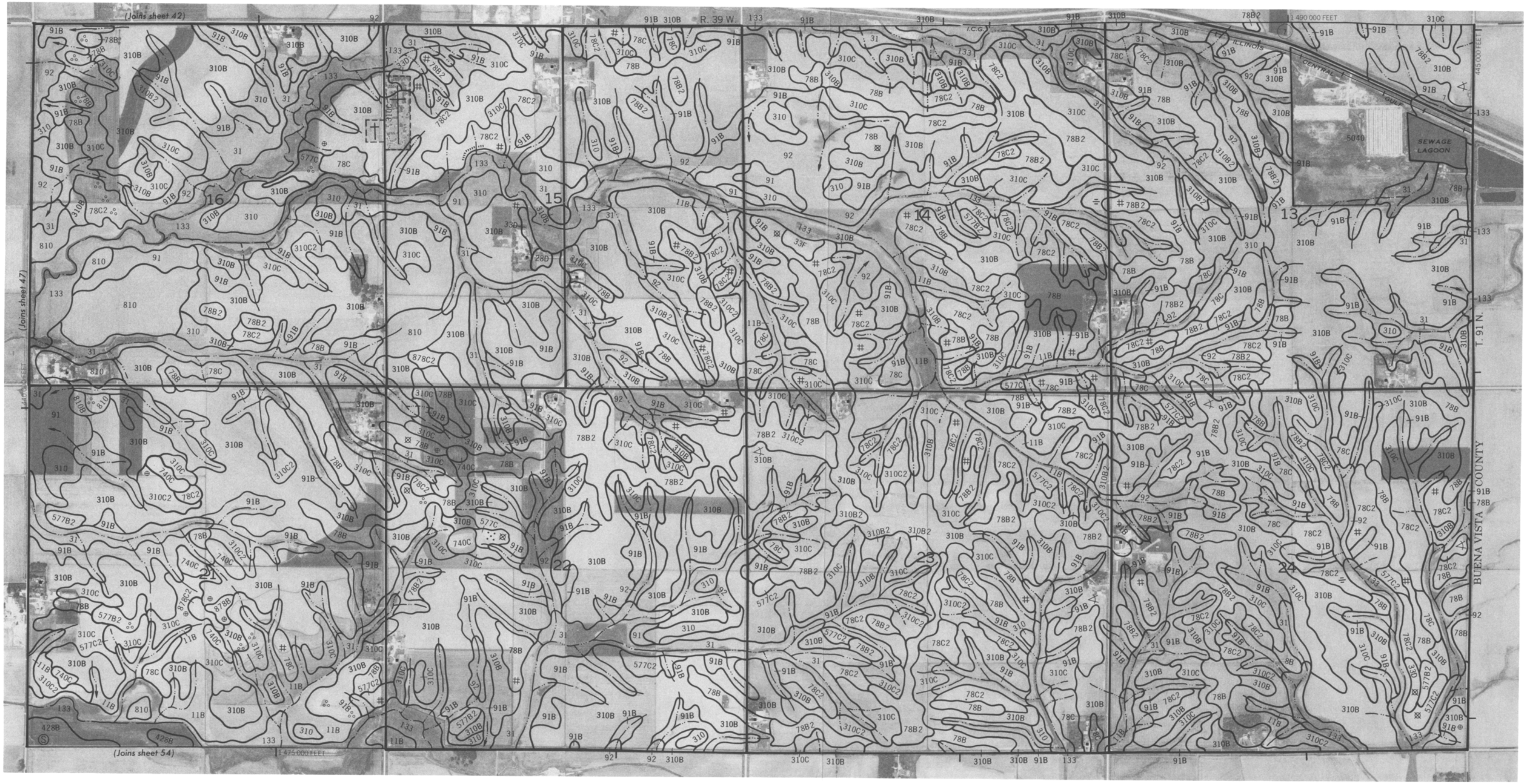
N



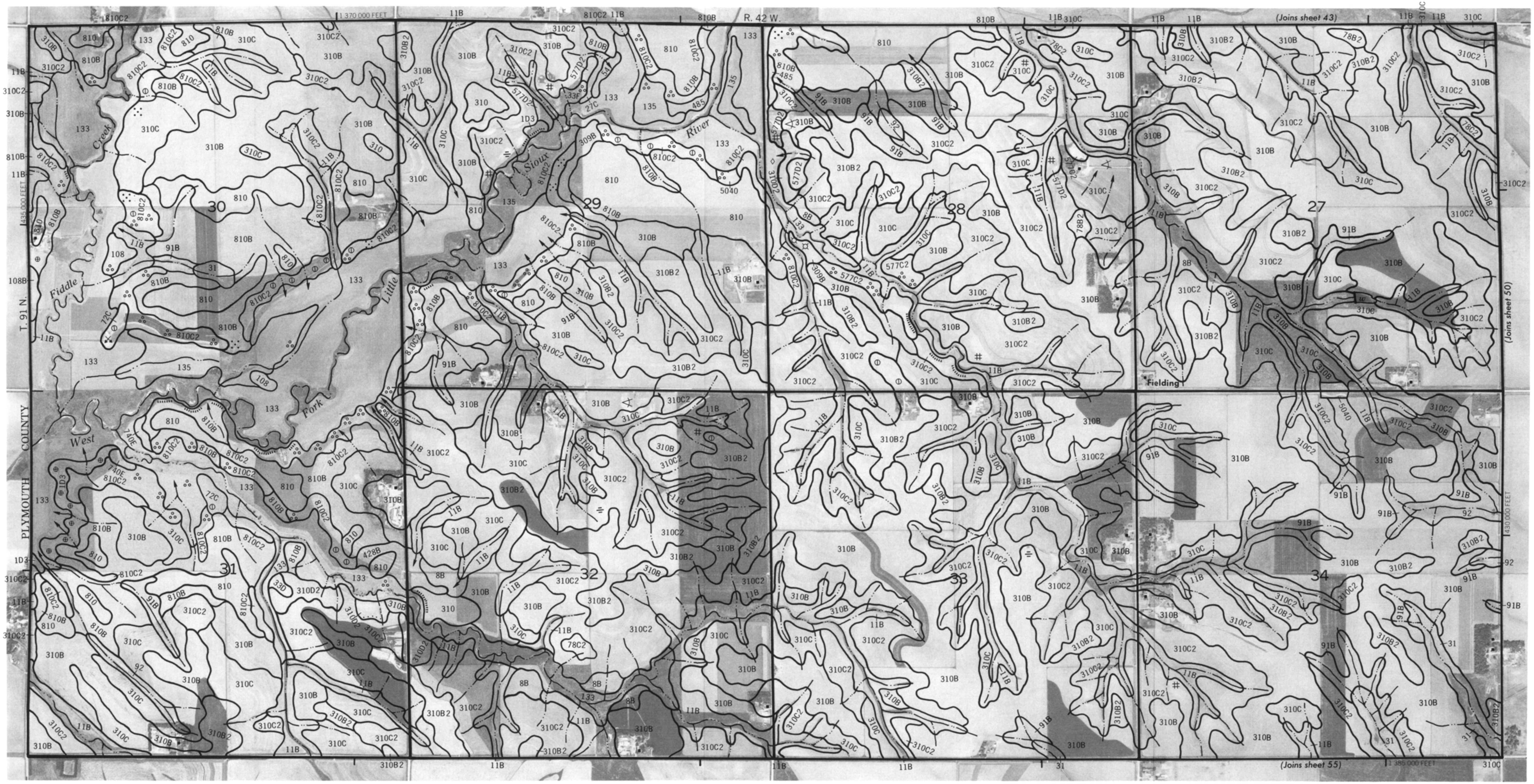
N


(Joins sheet 41)
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 53)
R. 40 W.
R. 39 W.
T. 91 N.
1 455 000 FEET
1 470 000 FEET
445 000 FEET
440 000 FEET
13
14
17
18
19
20
23
24
Maple River
Maple River
water
water

N


(Joins sheet 42)
(Joins sheet 47)
(Joins sheet 54)
R. 39 W.
T. 91 N.
BUENA VISTA COUNTY
I.C.G.
ILLINOIS CENTRAL GULF
SEWAGE LAGOON
1 490 000 FEET
445 000 FEET
1 475 000 FEET
16
15
14
13
21
22
23
24

N

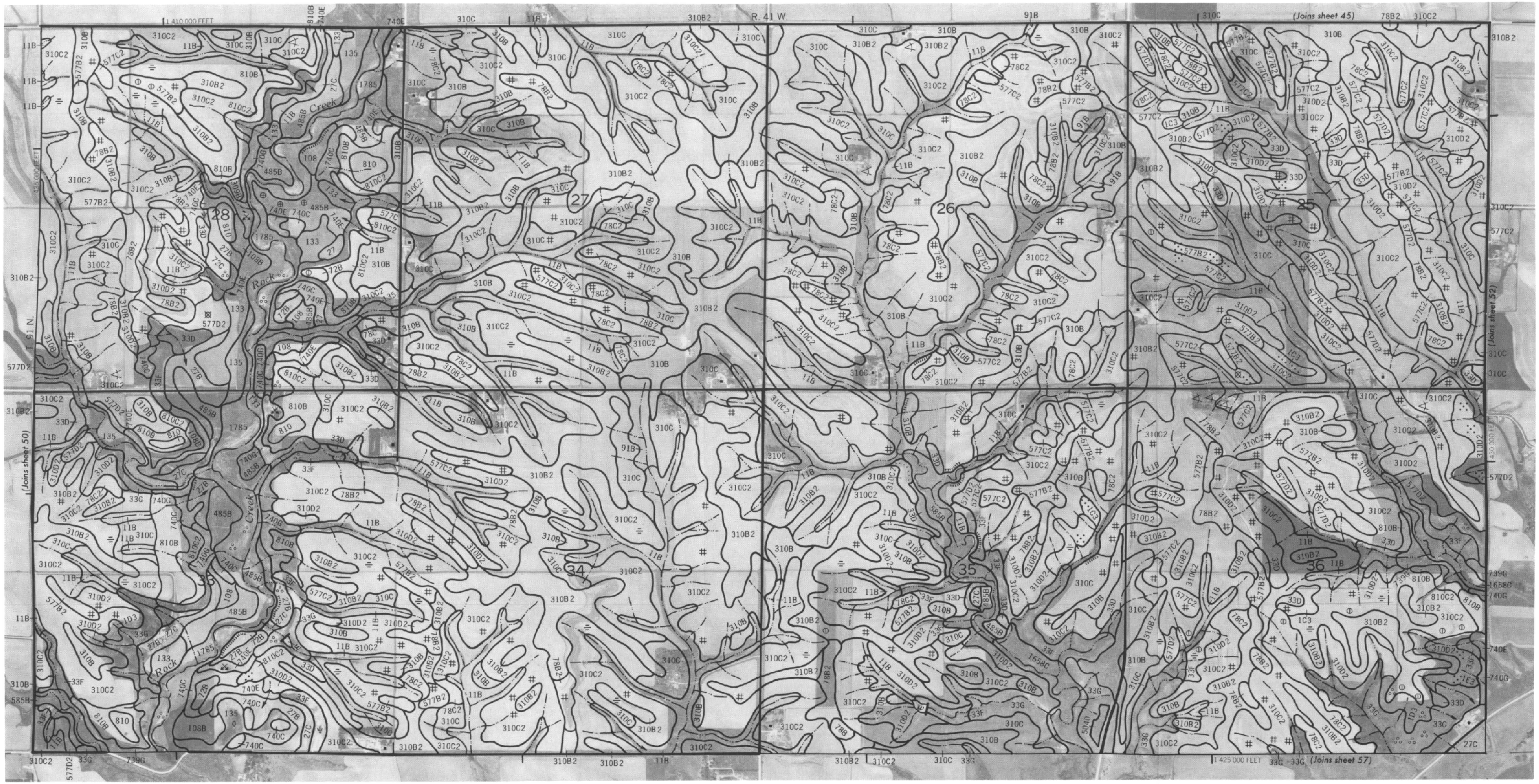

R. 42 W.
(Joins sheet 43)
(Joins sheet 50)
(Joins sheet 55)
T. 91 N.
PLYMOUTH COUNTY
1 370 000 FEET
1 385 000 FEET
435 000 FEET
430 000 FEET
Fielding
Little Sioux River
West Fork
Fiddle Creek
30
29
28
27
31
32
33
34

50

N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 50

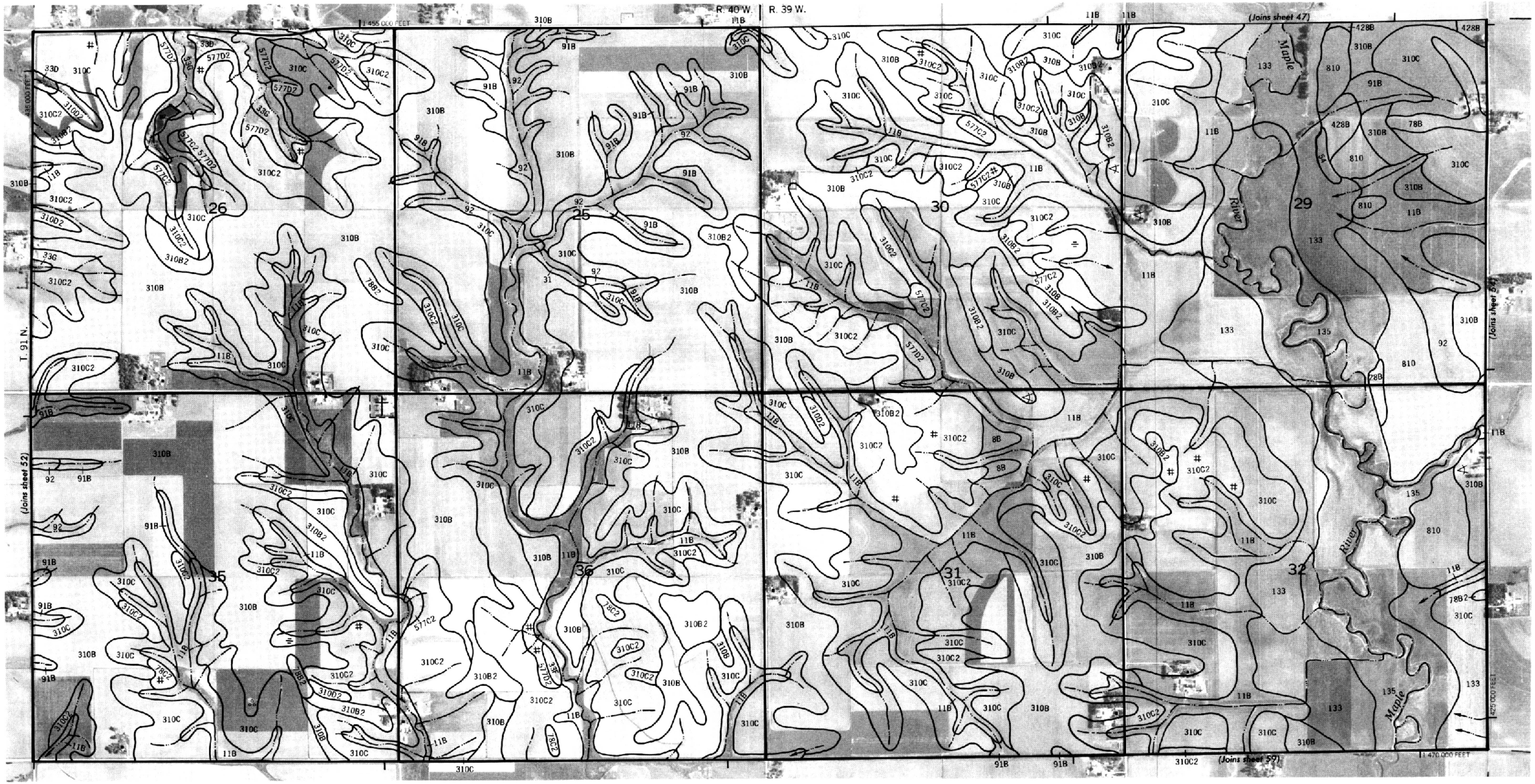
N

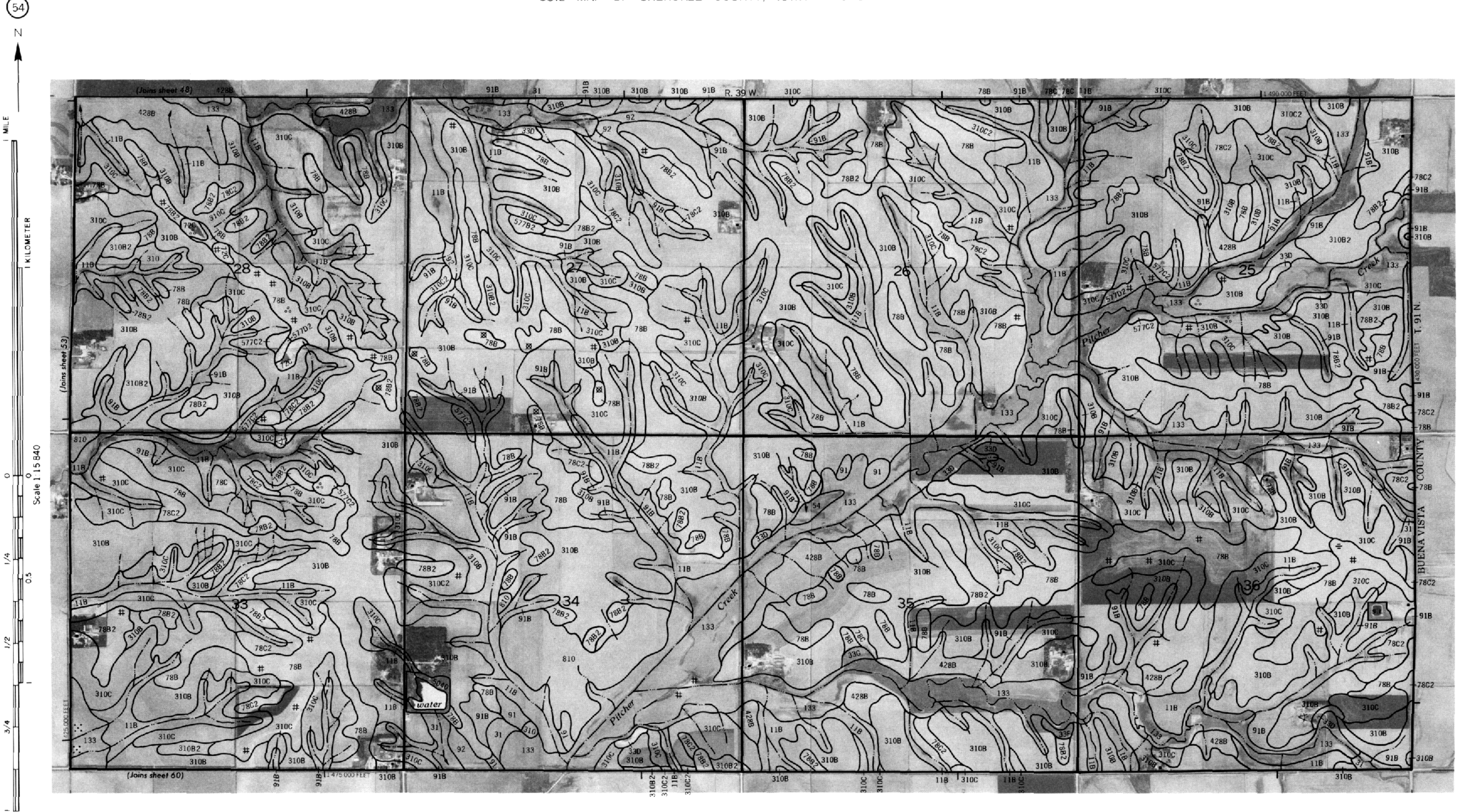

R. 41 W.
T. 91 N.
1 410 000 FEET
1 425 000 FEET
(Joins sheet 45)
(Joins sheet 52)
(Joins sheet 57)
(Joins sheet 50)
Rock Creek
28
27
26
25
33
34
35
36

N

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 52

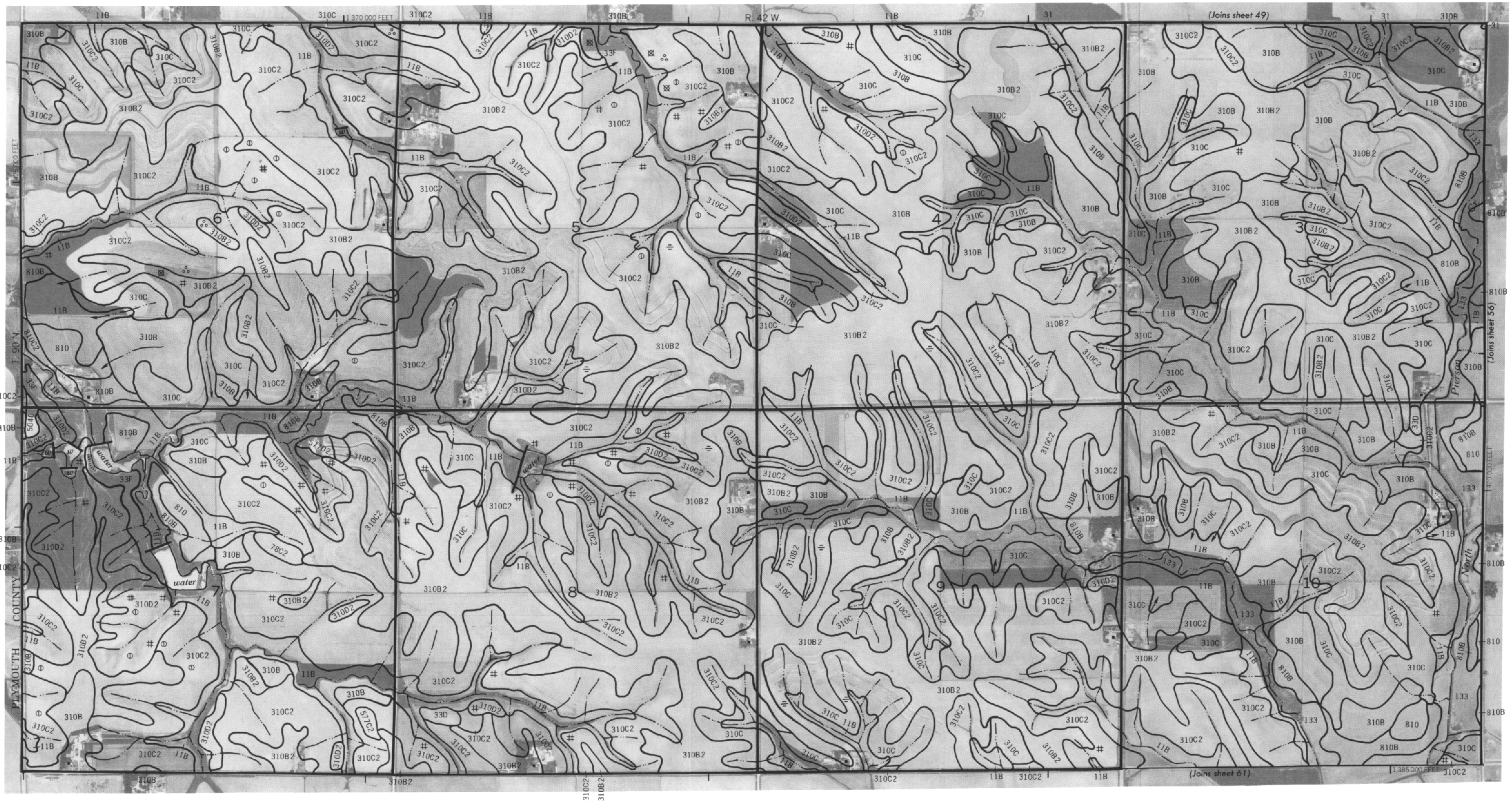
N


R. 40 W.
R. 39 W.
T. 91 N.
1 455 000 FEET
1 470 000 FEET
435 000 FEET
425 000 FEET
(Joins sheet 47)
(Joins sheet 52)
(Joins sheet 54)
(Joins sheet 59)
26
25
30
29
35
36
31
32
Maple
River
310B
310C
310C2
310B2
310D2
11B
91B
92
133
135
810
428B
78B
78B2
78C2
577C2
577D2
33D
33G
33F
8B
28B
31
54

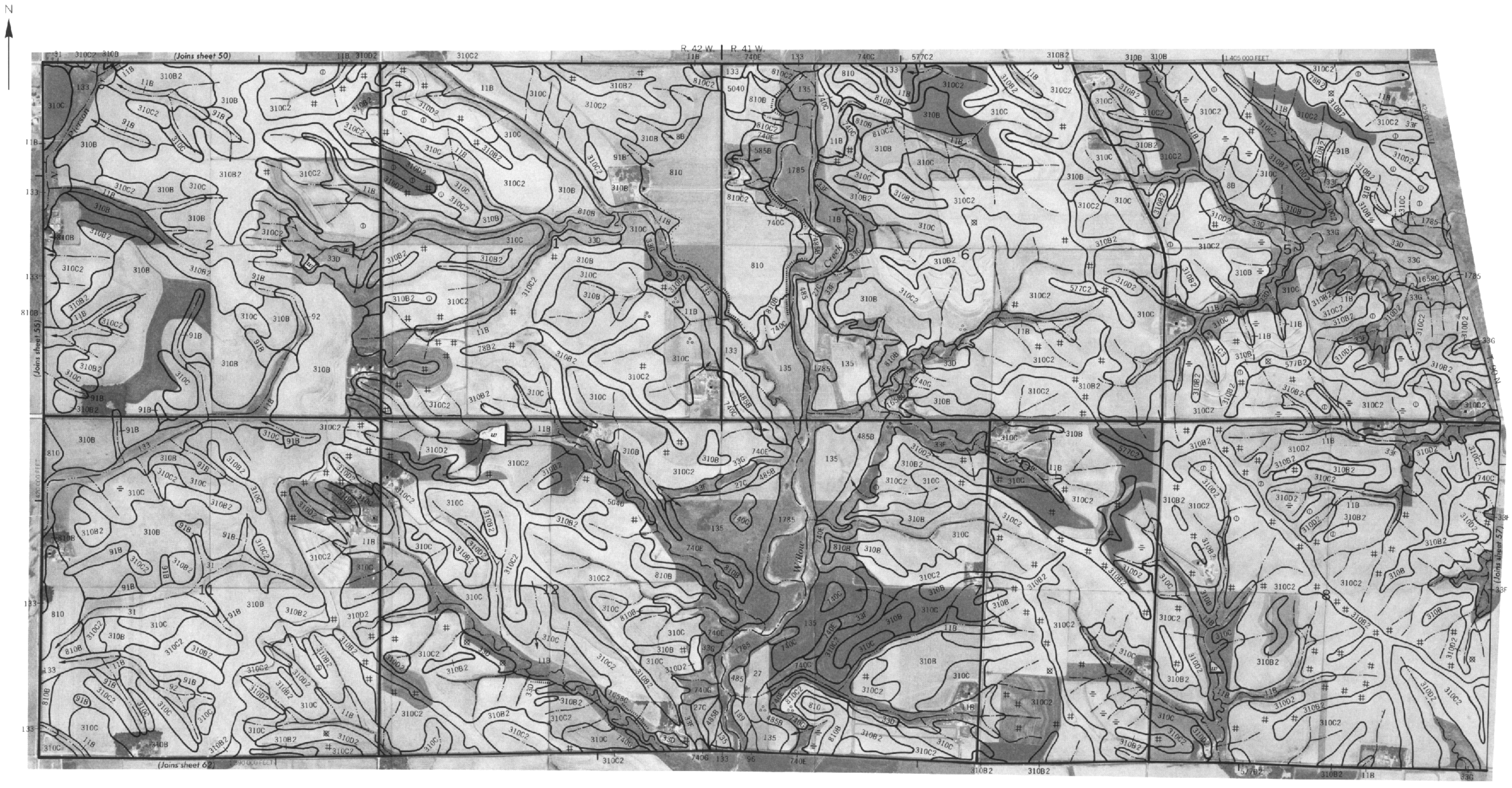

N
1 MILE
1 KILOMETER
Scale 1:15 840
0
1/4
0.5
1/2
3/4
1
(Joins sheet 48)
(Joins sheet 53)
(Joins sheet 60)
R. 39 W.
T. 91 N.
BUENA VISTA COUNTY
1 490 000 FEET
1 475 000 FEET
625 000 FEET
630 000 FEET
Pitcher Creek
water
28
27
26
25
33
34
35
36

55

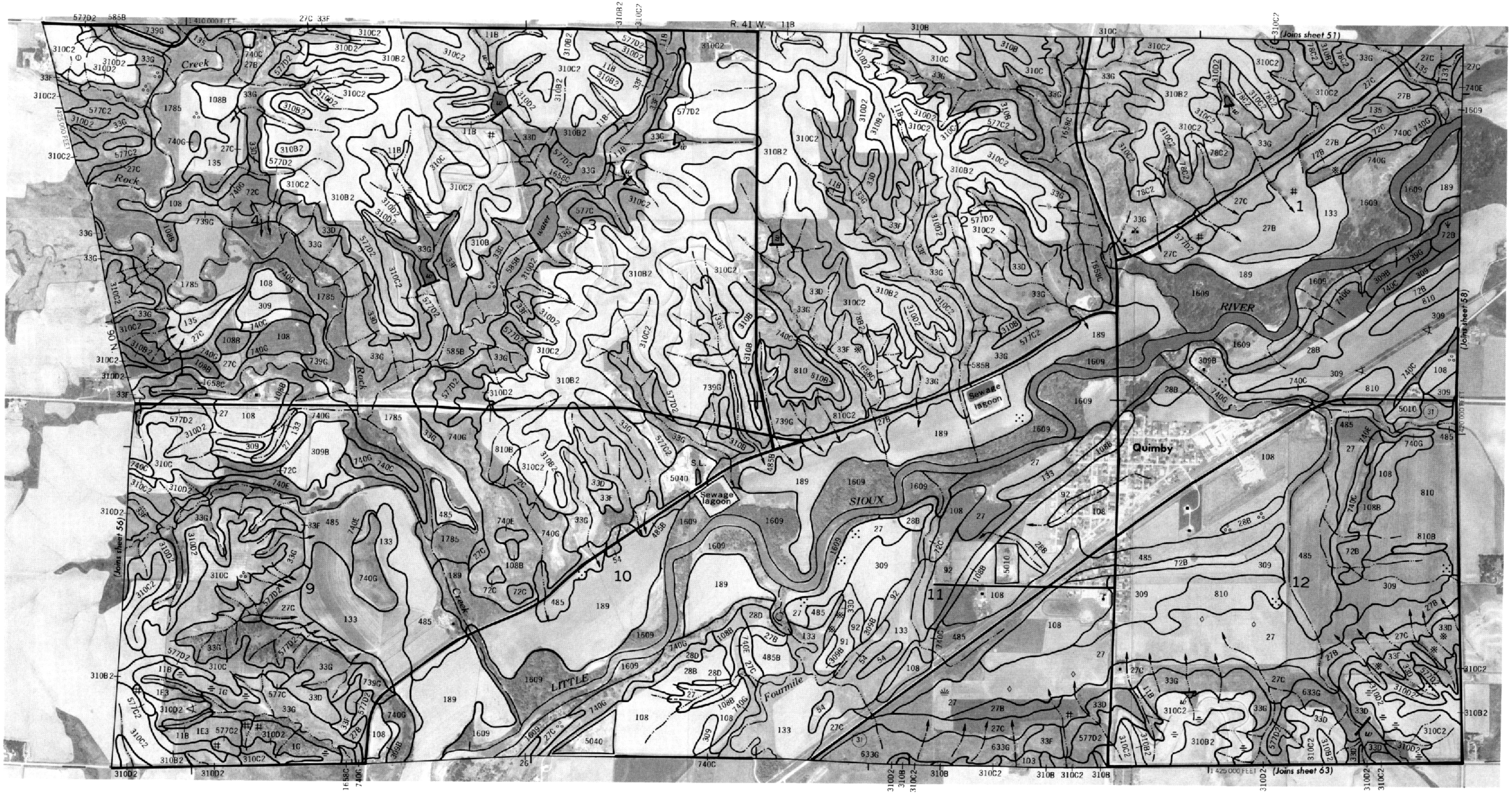
N


R. 42 W.
(Joins sheet 49)
(Joins sheet 56)
(Joins sheet 61)
1 370 000 FEET
1 385 000 FEET
T. 90 N.
PLYMOUTH COUNTY
water
Pierson
North
6
5
4
3
7
8
9
10

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 56

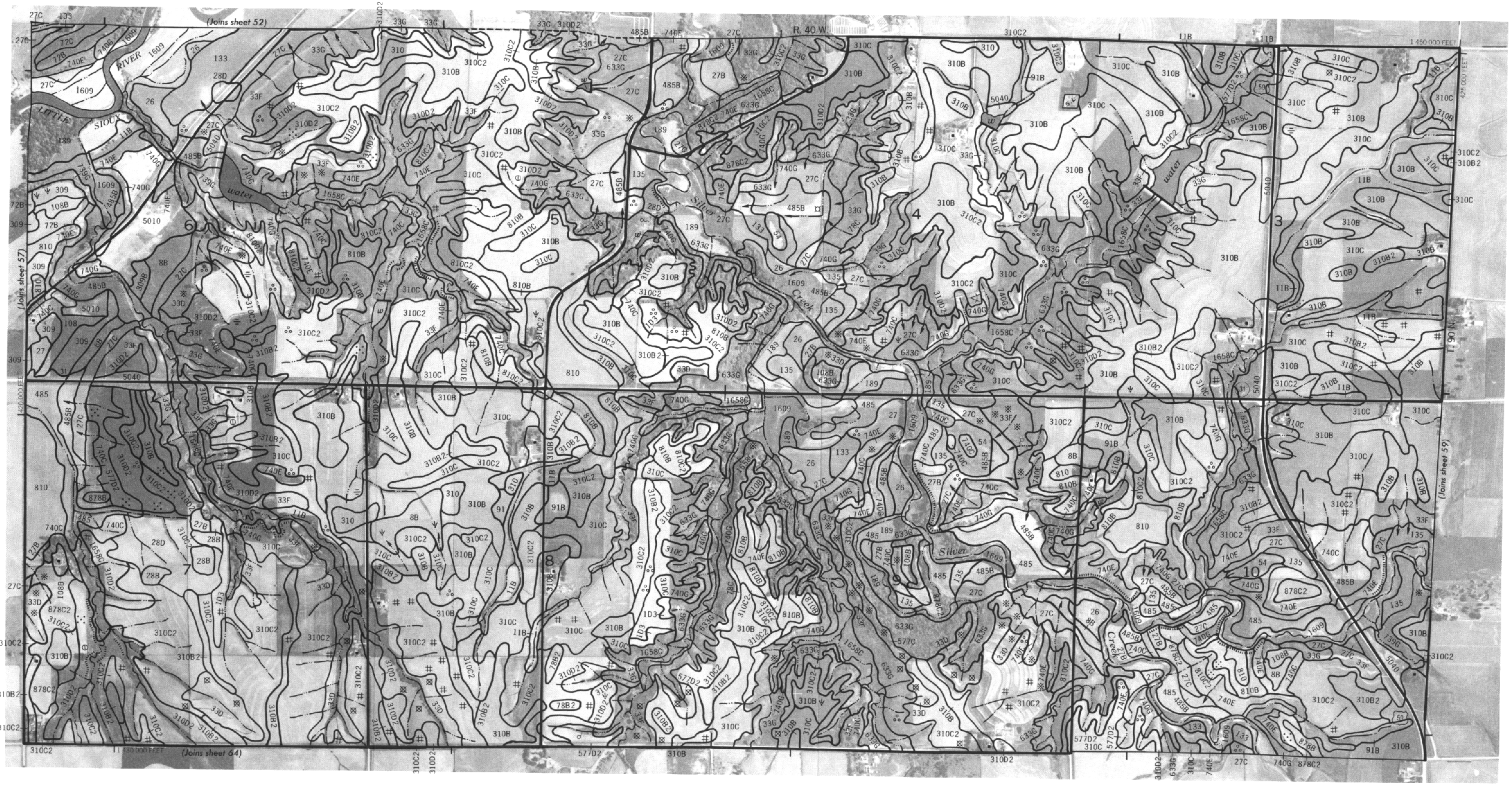


N

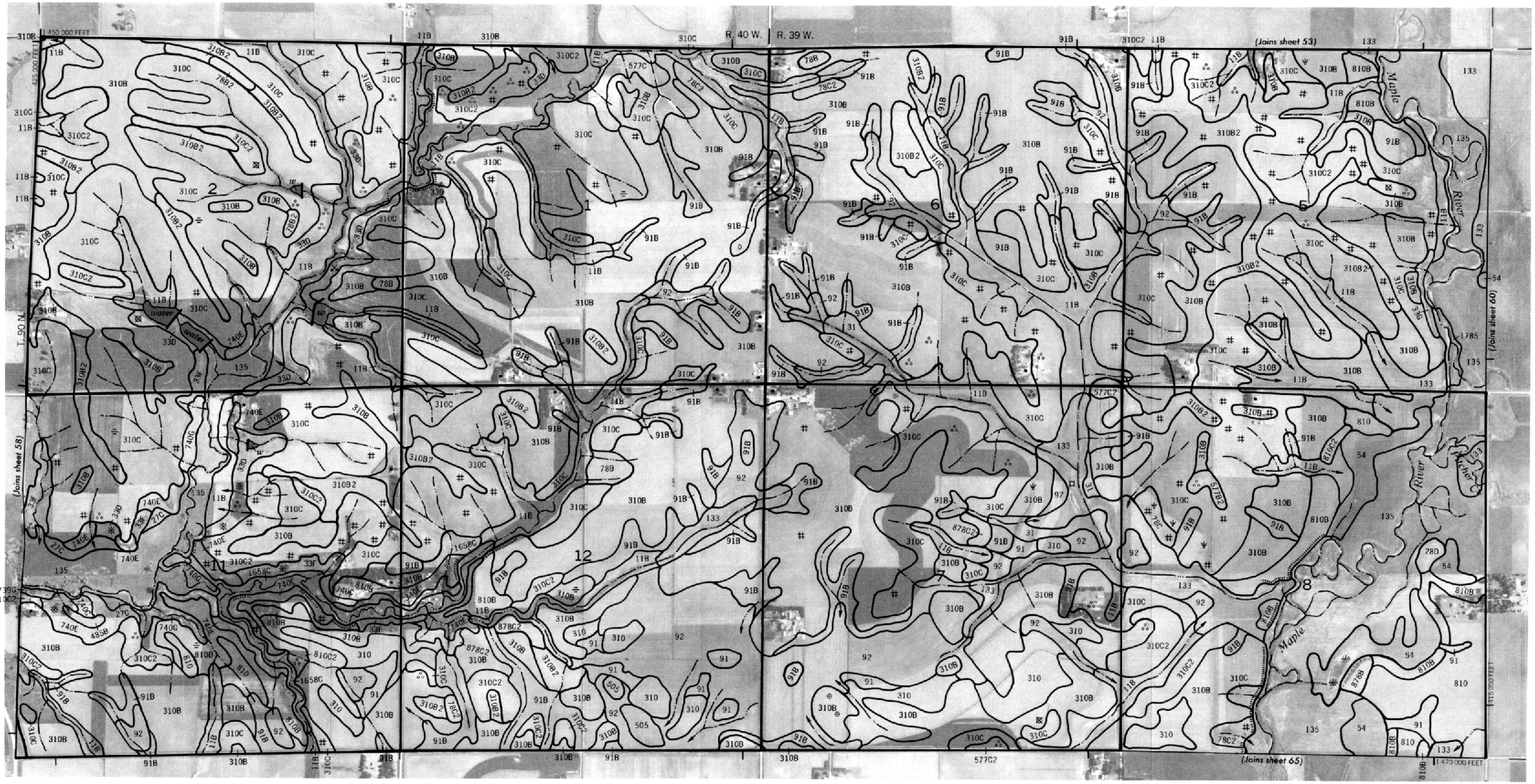

1 410 000 FEET
R. 41 W.
(Joins sheet 51)
(Joins sheet 58)
(Joins sheet 63)
(Joins sheet 56)
1 425 000 FEET
420 000 FEET
425 000 FEET
T. 90 N.
Creek
Rock
Rock
Creek
LITTLE
SIOUX
RIVER
Fourmile
Quimby
Sewage lagoon
Sewage lagoon
S.L.
water
1
2
3
4
9
10
11
12

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 58

N

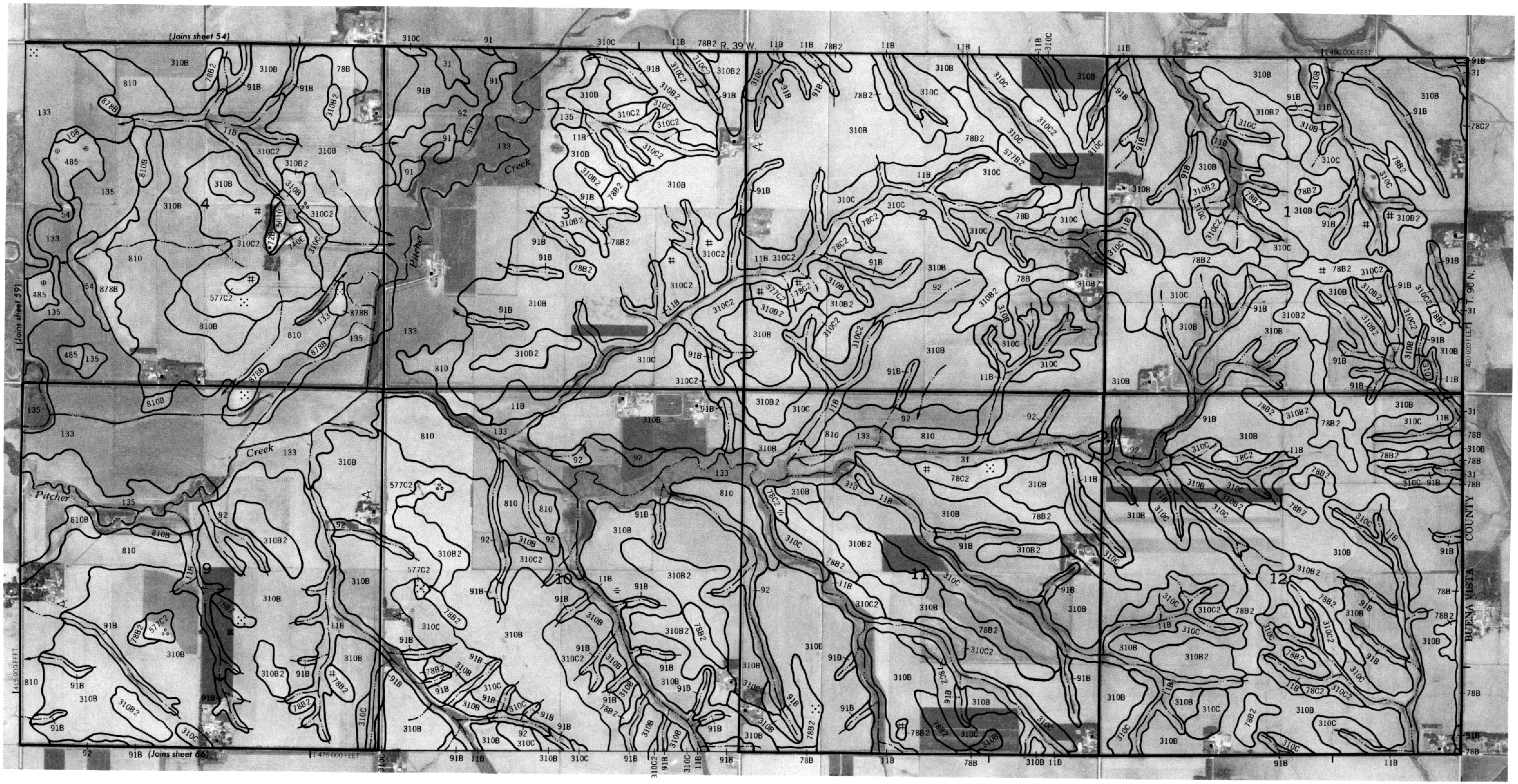


N


R. 40 W.
R. 39 W.
T. 90 N.
1 450 000 FEET
425 000 FEET
415 000 FEET
1 470 000 FEET
(Joins sheet 53)
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 65)
Maple River
Maple
River
water
1
2
5
6
7
8
11
12

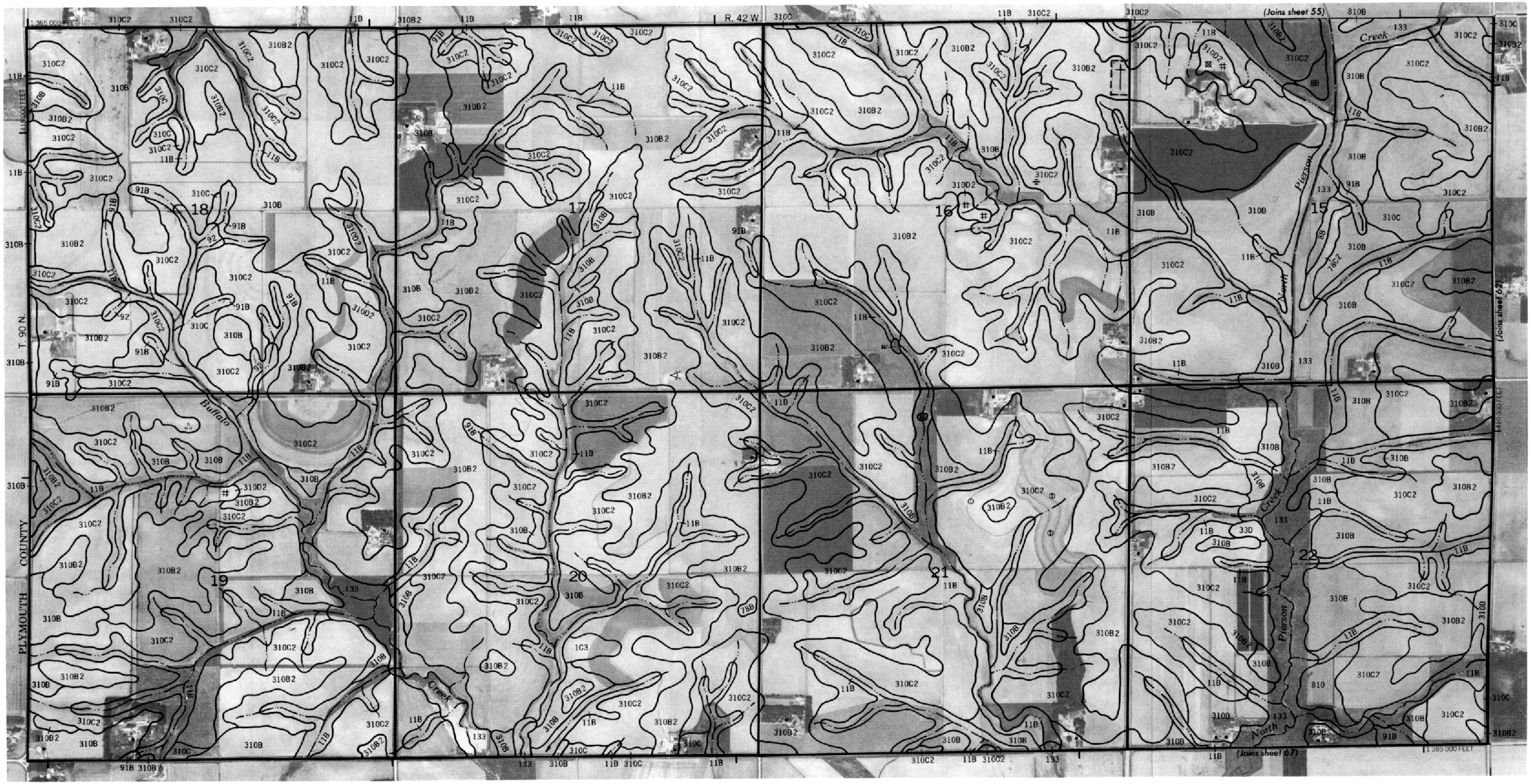
SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 60

N

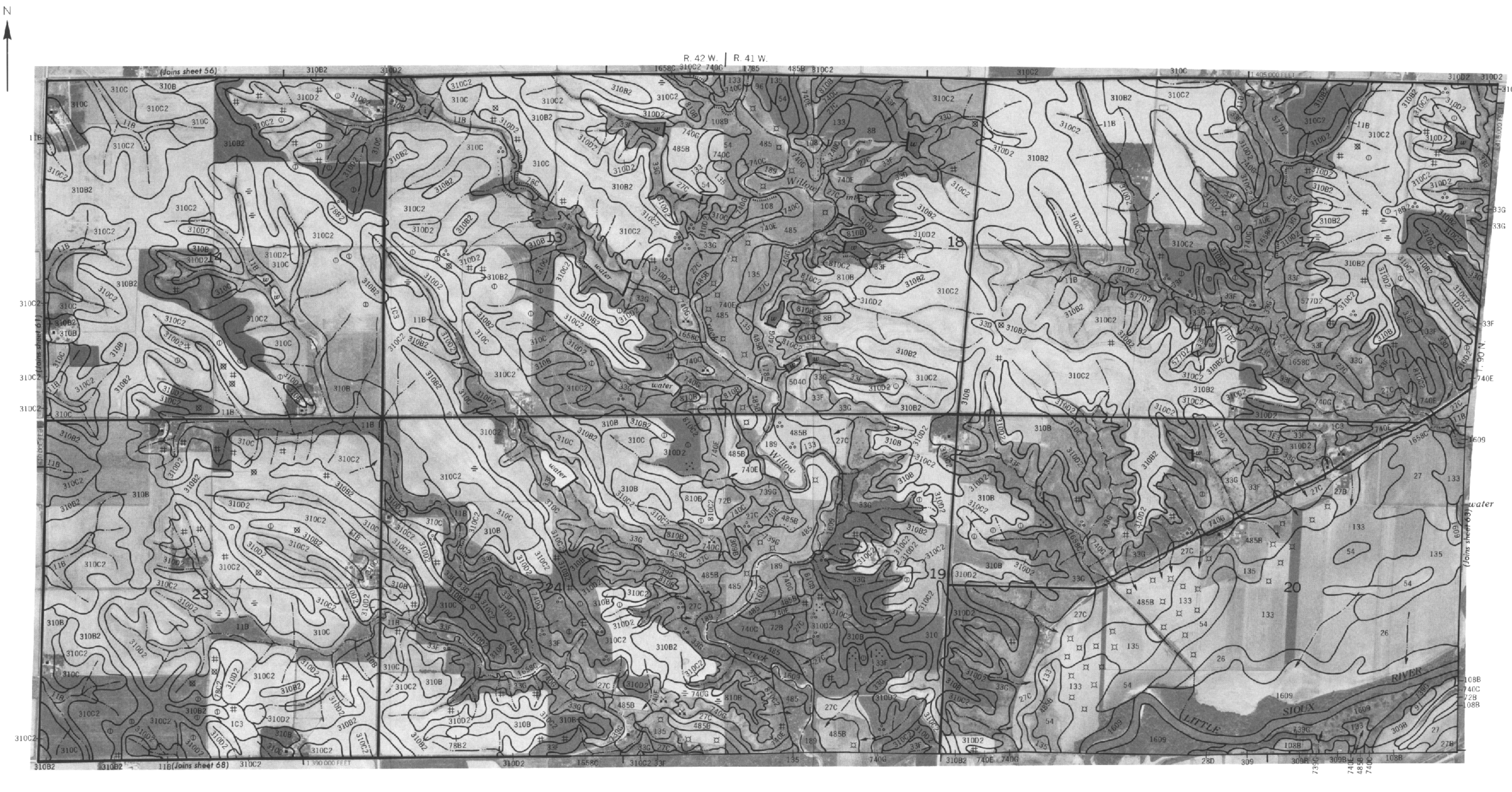


61

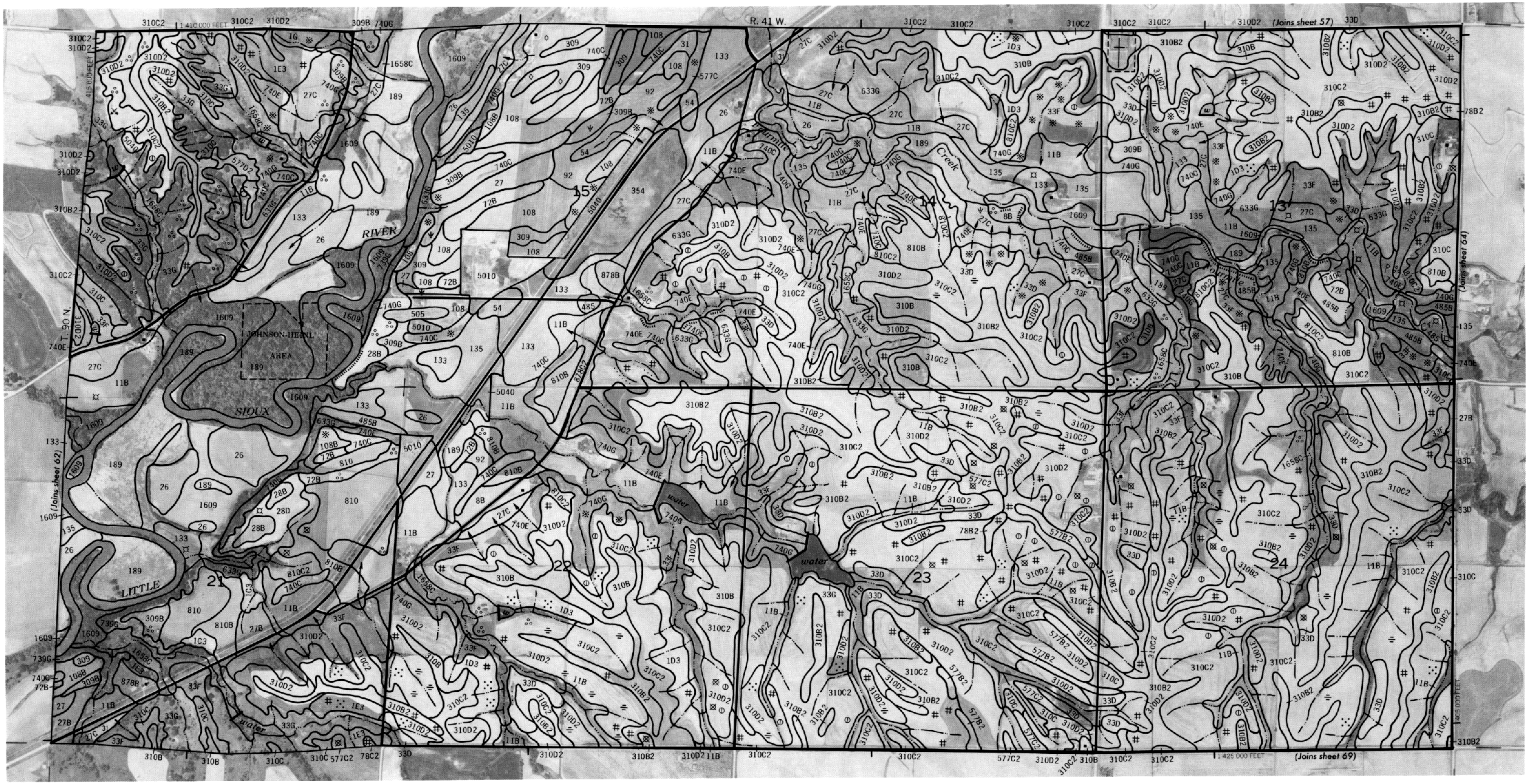
N


(Joins sheet 55)
(Joins sheet 62)
(Joins sheet 67)
R. 42 W.
T. 90 N.
PLYMOUTH COUNTY
1 365 000 FEET
1 385 000 FEET
18
17
16
15
19
20
21
22
Buffalo
Creek
North
Pierson
310B
310B2
310C
310C2
310D2
11B
91B
92
133
8B
810B
1C3
33D
810

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 62

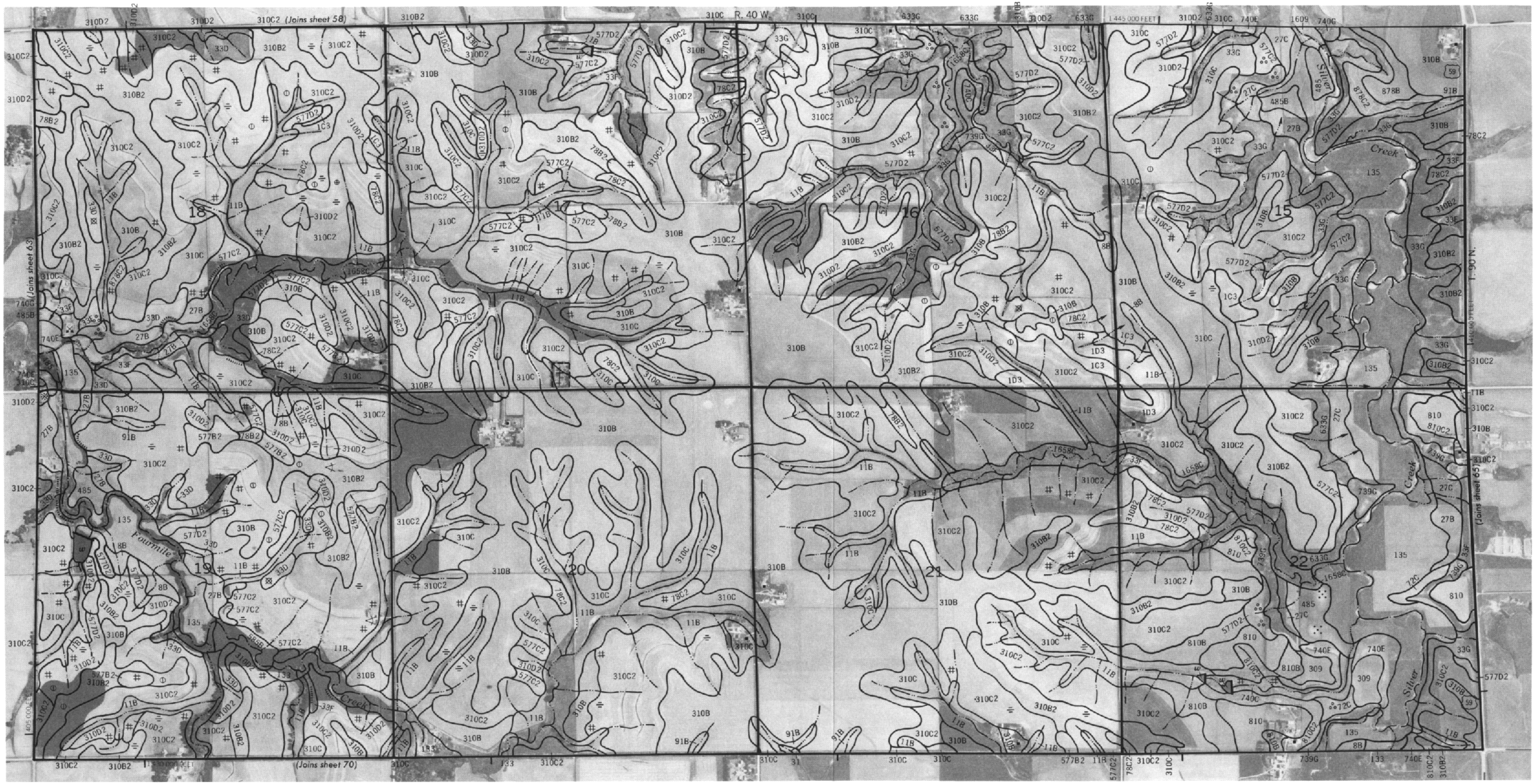


N


R. 41 W.
(Joins sheet 57)
(Joins sheet 64)
(Joins sheet 69)
(Joins sheet 62)
T. 90 N.
1 410 000 FEET
1 425 000 FEET
JOHNSON-HEINL AREA
SIOUX
RIVER
LITTLE
Creek
water
13
14
15
16
21
22
23
24

SOIL MAP OF CHEROKEE COUNTY, IOWA — SHEET NUMBER 64

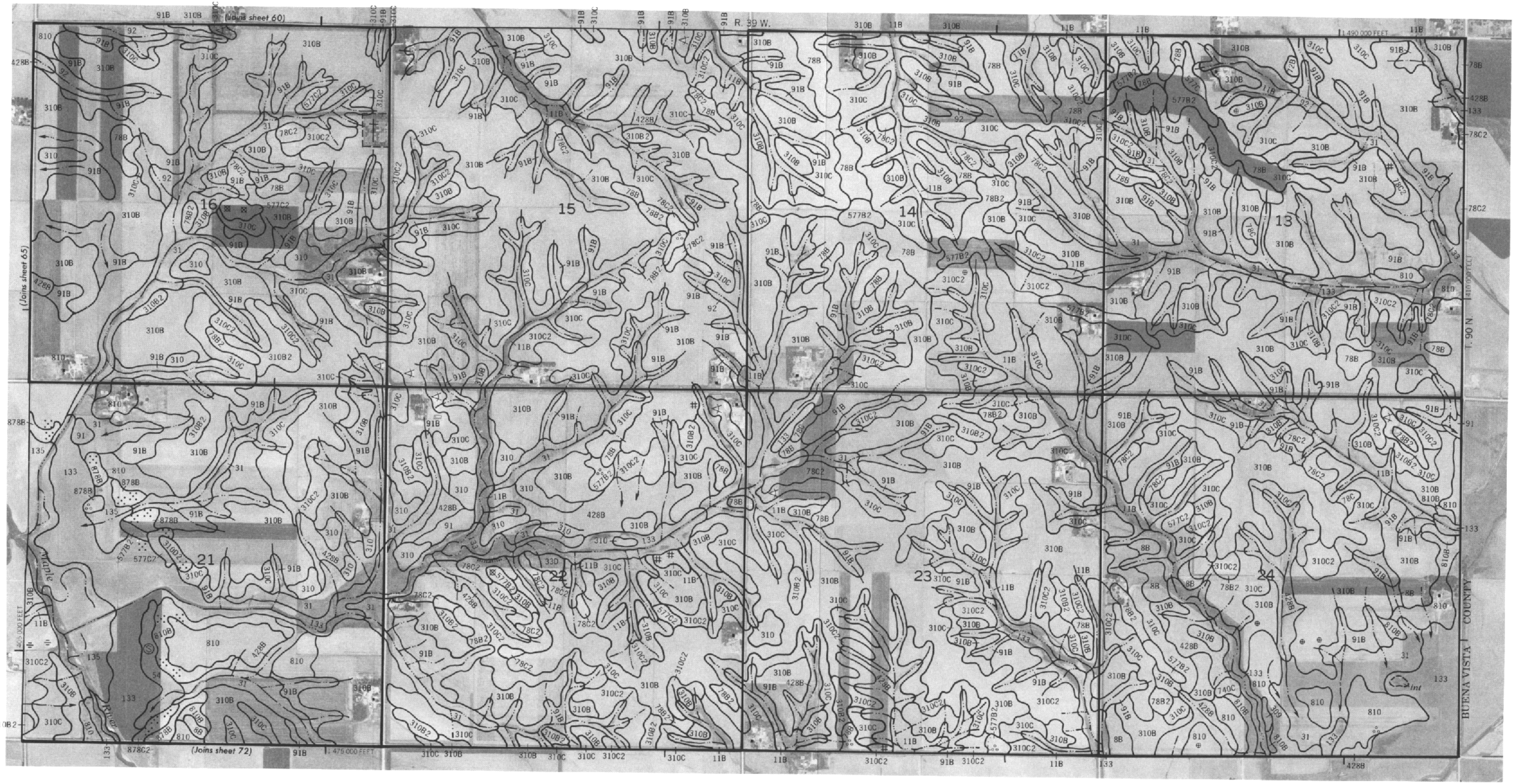
N



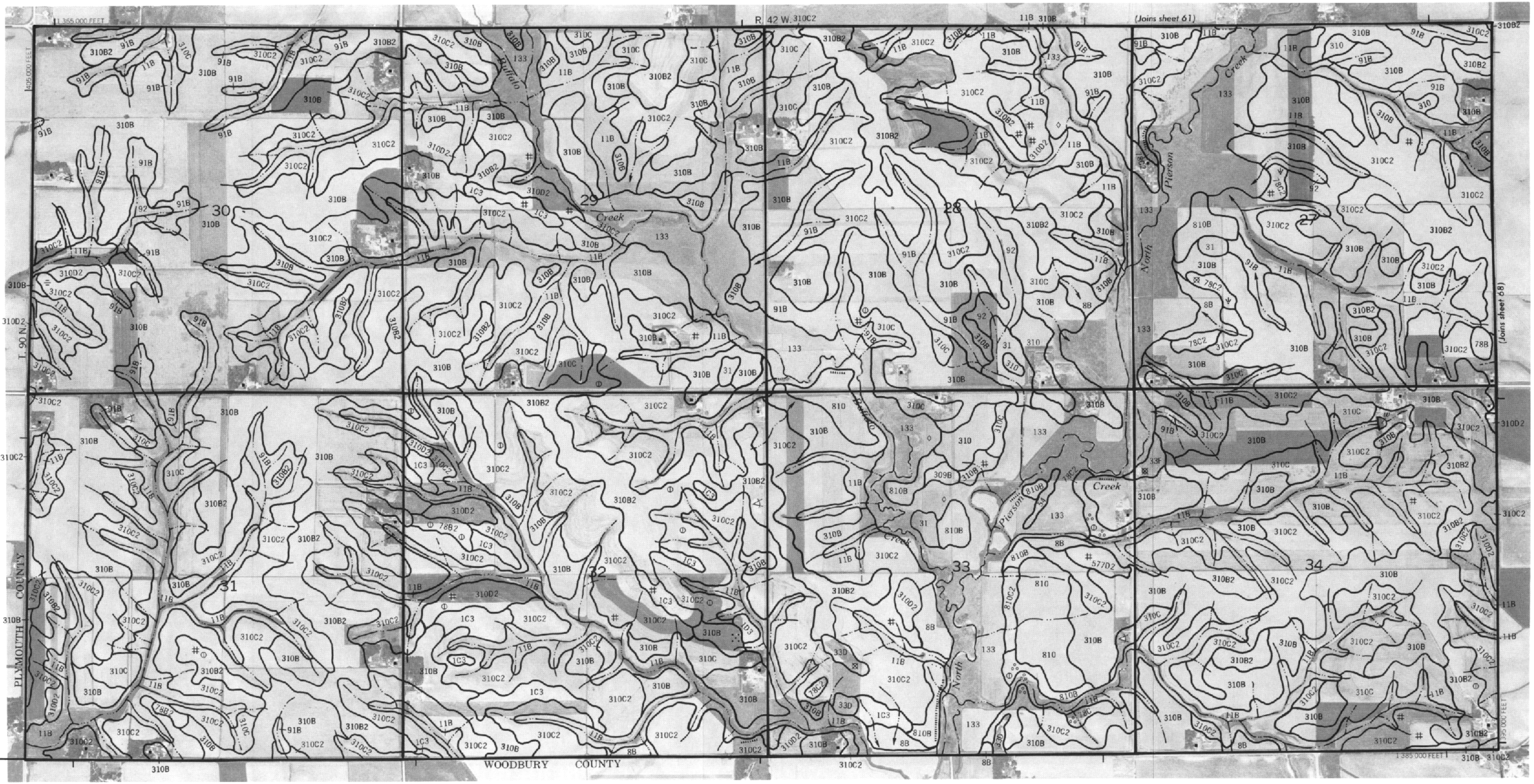
N


R. 40 W.
R. 39 W.
T. 90 N
1 450 000 FEET
1 470 000 FEET
(Joins sheet 59)
(Joins sheet 66)
(Joins sheet 71)
(Joins sheet 64)
14
13
18
17
23
24
19
20
Maple
River
water
Sewage lagoon
S.L.

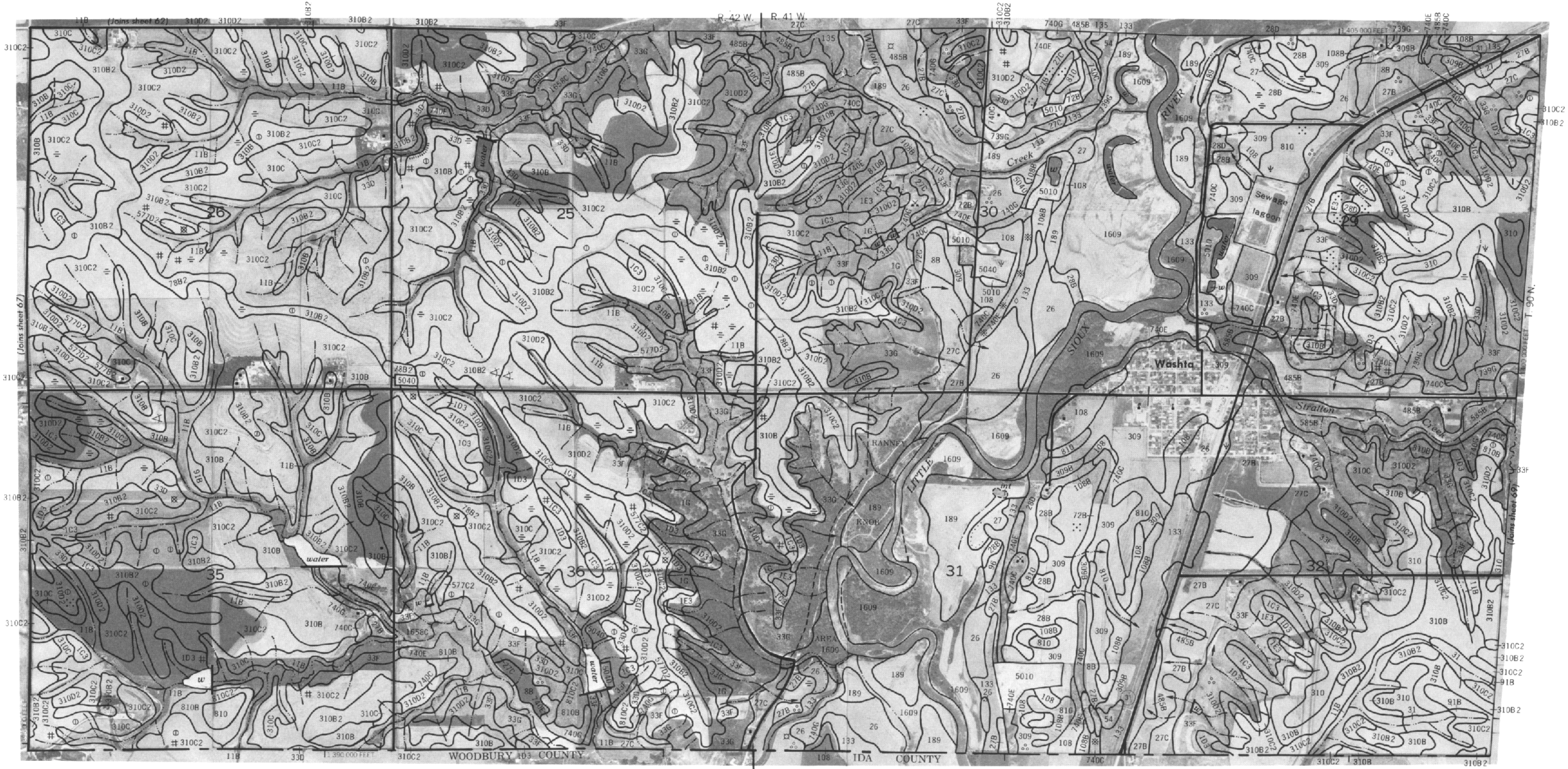
N


(Joins sheet 60)
(Joins sheet 65)
(Joins sheet 72)
R. 39 W.
T. 90 N.
1 490 000 FEET
1 475 000 FEET
410 000 FEET
405 000 FEET
BUENA VISTA COUNTY
Maple River
16
15
14
13
21
22
23
24

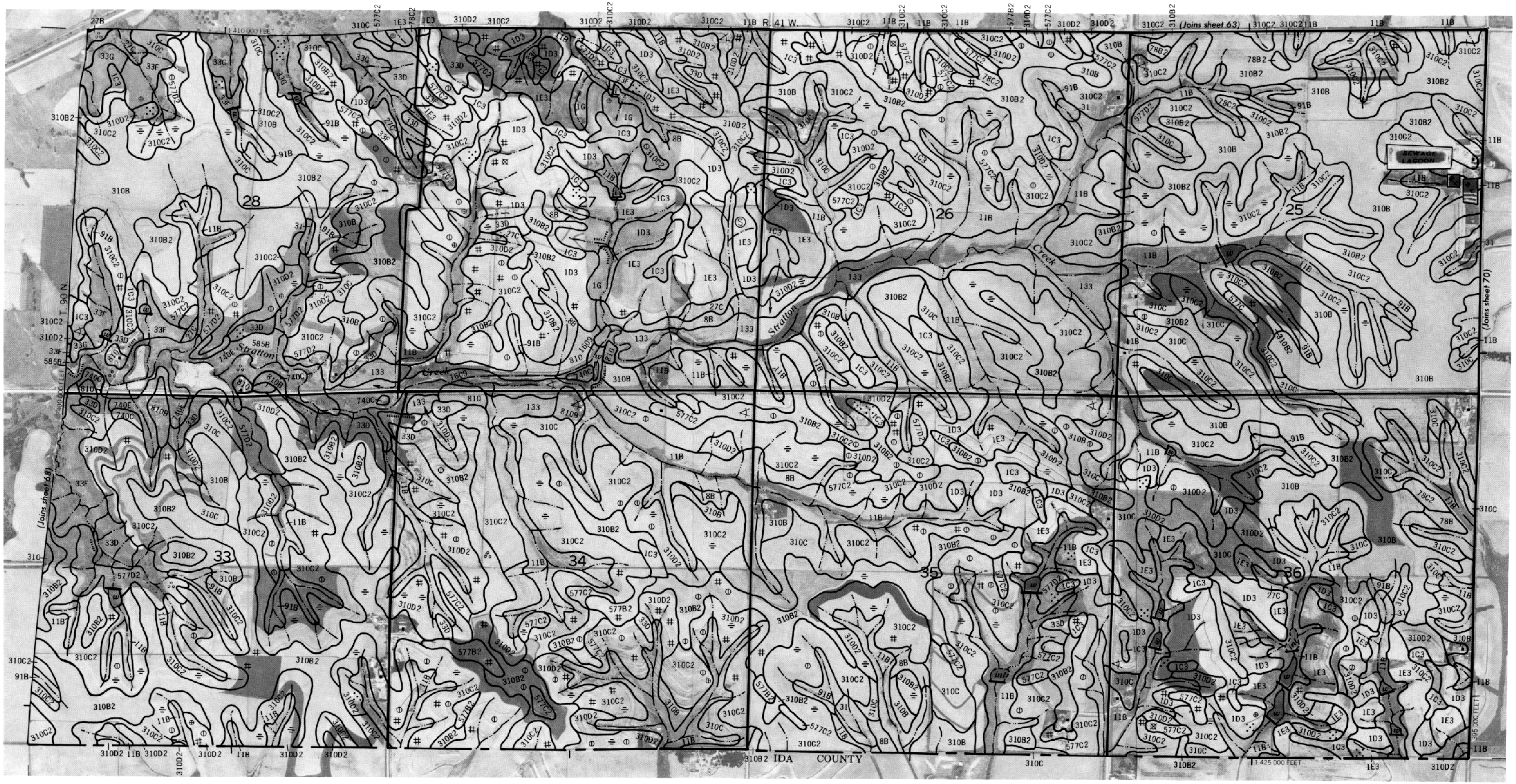
N


R. 42 W.
(Joins sheet 61)
(Joins sheet 68)
1 365 000 FEET
1 385 000 FEET
T. 90 N.
PLYMOUTH COUNTY
WOODBURY COUNTY
Buffalo
Creek
North
Pierson
Creek
29
28
27
30
31
32
33
34

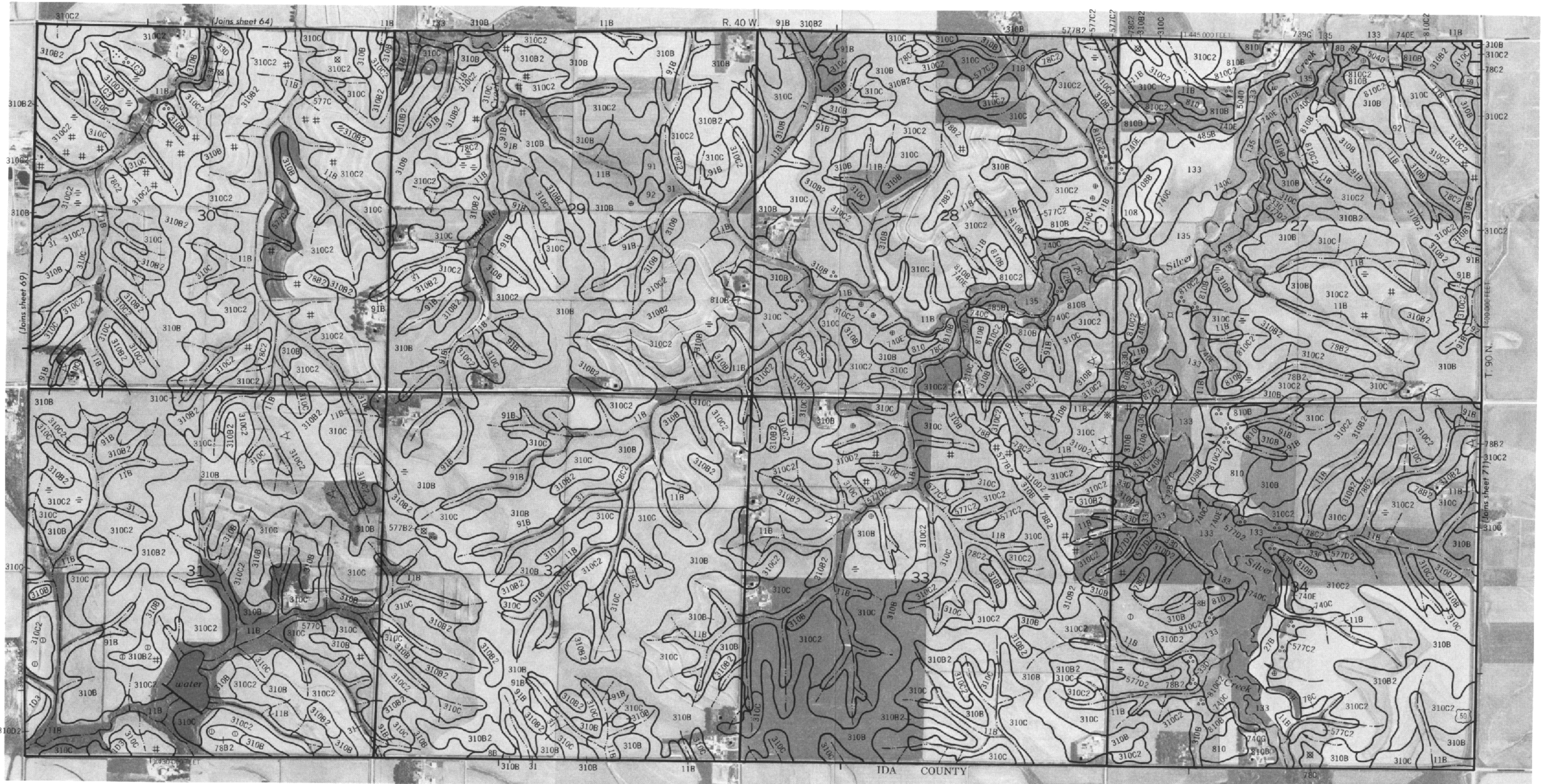
N


(Joins sheet 62)
(Joins sheet 67)
(Joins sheet 69)
R. 42 W.
R. 41 W.
T. 90 N.
1 405 000 FEET
1 390 000 FEET
WOODBURY COUNTY
IDA COUNTY
Washta
Sewage lagoon
SIOUX
RIVER
LITTLE
Willow
Creek
Stratton
Creek
RANNEY
KNOB
AREA
water
26
25
30
29
35
36
31
32

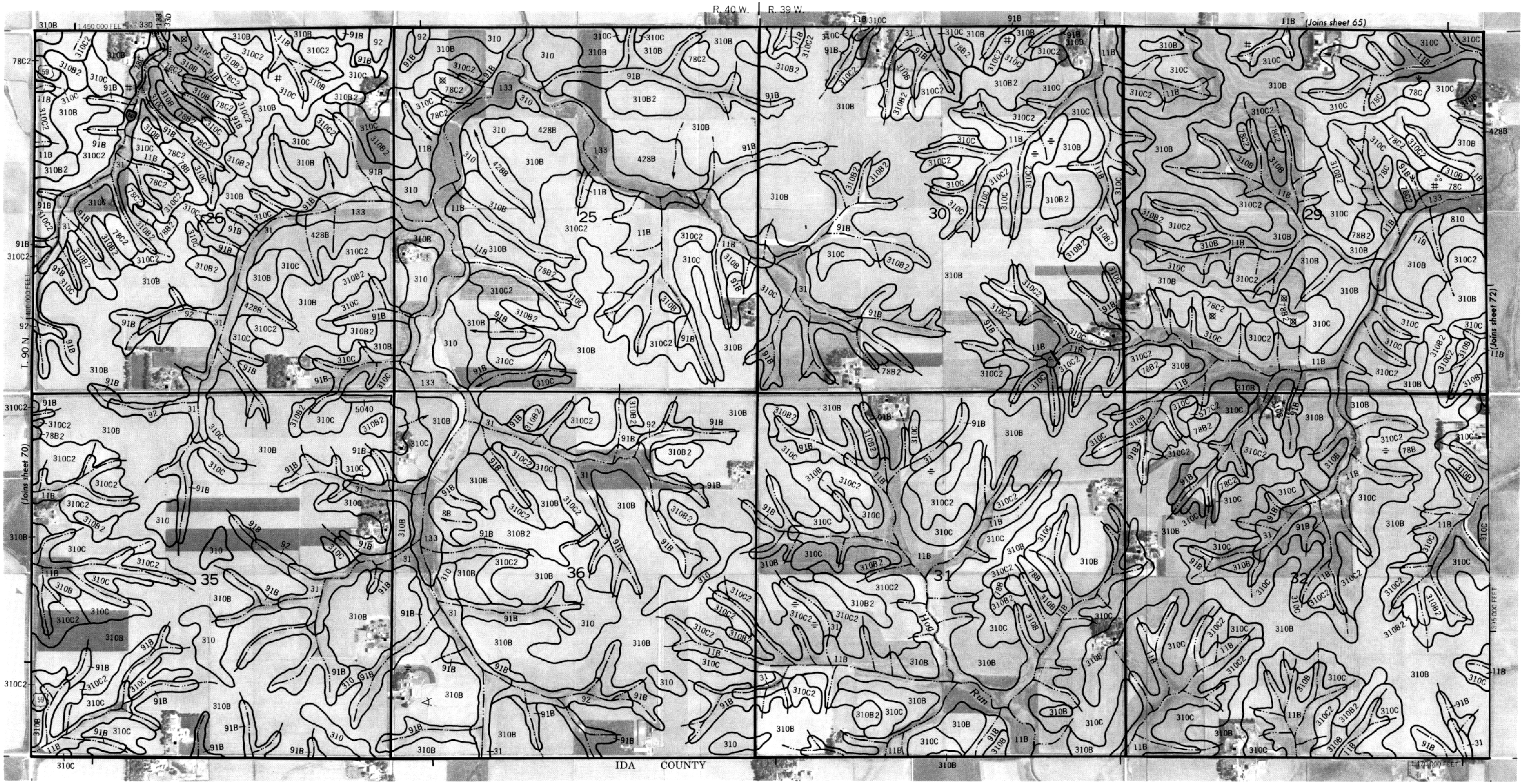
N


R. 41 W.
T. 90 N.
(Joins sheet 63)
(Joins sheet 70)
(Joins sheet 68)
1 410 000 FEET
1 425 000 FEET
IDA COUNTY
SEWAGE LAGOON
Stratton Creek
28
27
26
25
33
34
35
36

N


(Joins sheet 64)
R. 40 W.
1 445 000 FEET
(Joins sheet 69)
(Joins sheet 71)
T. 90 N.
30
29
28
27
31
32
33
34
Silver Creek
water
IDA COUNTY

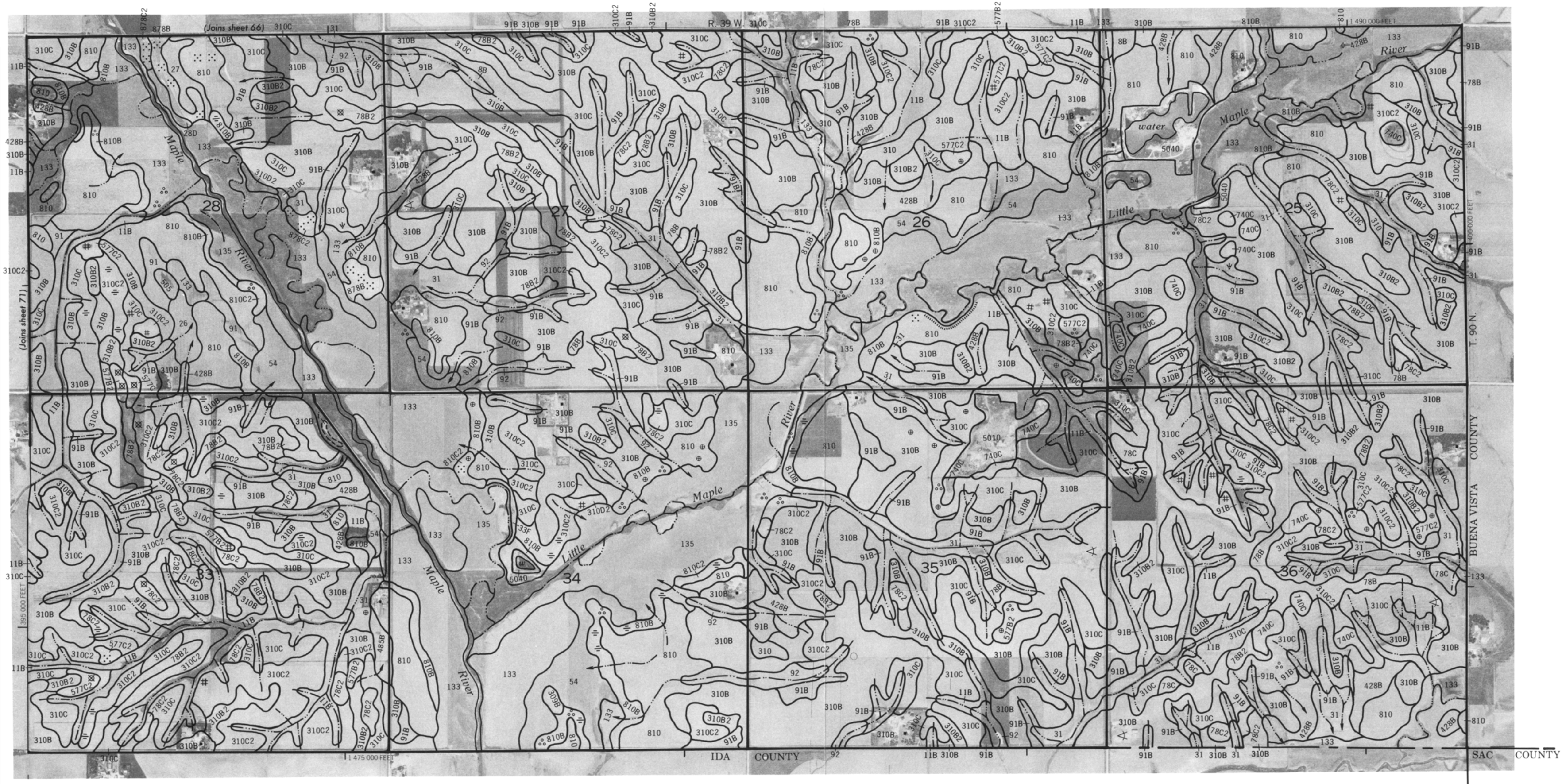
N



R. 40 W.
R. 39 W.
(Joins sheet 65)
(Joins sheet 72)
(Joins sheet 70)
T. 90 N.
IDA COUNTY
26
25
30
29
35
36
31
32
Hog Run

72

N


(Joins sheet 66)
(Joins sheet 71)
R. 39 W.
T. 90 N.
1 490 000 FEET
1 475 000 FEET
395 000 FEET
400 000 FEET
Maple River
Little Maple River
water
27
28
25
26
33
34
35
36
IDA COUNTY
SAC COUNTY
BUENA VISTA COUNTY